From Boxkite to Jet

Memoirs of
Air Vice-Marshal
ERNEST W. STEDMAN

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Foreword

These memoirs of A. V.-M. Ernest W. Stedman were first published serially in the magazine *Canadian Aviation.*

Stedman came to Canada in 1919 in charge of the Handley Page aeroplane which was to attempt the Atlantic crossing from Newfoundland for the London *Daily Mail* prize of £10,000, but Alcock and Brown took off on June 14, 1919, and completed the crossing and won the prize.

Stedman attended the Royal College of Science and the City Guild College. He had a wealth of experience with the National Physics Laboratory and as Chief Engineer of the Handley Page Co. in England. He had also seen service with the R.N.A.S. in France during World War I. When the Air Board was formed in Canada, he was appointed Director of the Technical Branch on October 30, 1920. It was due to his efforts that regulations were drawn up governing the design of aircraft. He was the first Aeronautical Engineer in Canada.

When the R.C.A.F. was organized in 1924 Stedman joined and during World War II he rose to the rank of Air Vice-Marshal. His last post before retirement in 1946 was Air Member for Research and Development. He was the first in Canada to suggest the formation of an organization to investigate jet propulsion.

After retiring from the R.C.A.F. in 1946 he was appointed to the Engineering Department of Carleton College, Ottawa, where he became a moving spirit in bringing about what is now an expanding centre of education.

His passing in 1957 created a great loss to Canada.

T. R. Louden

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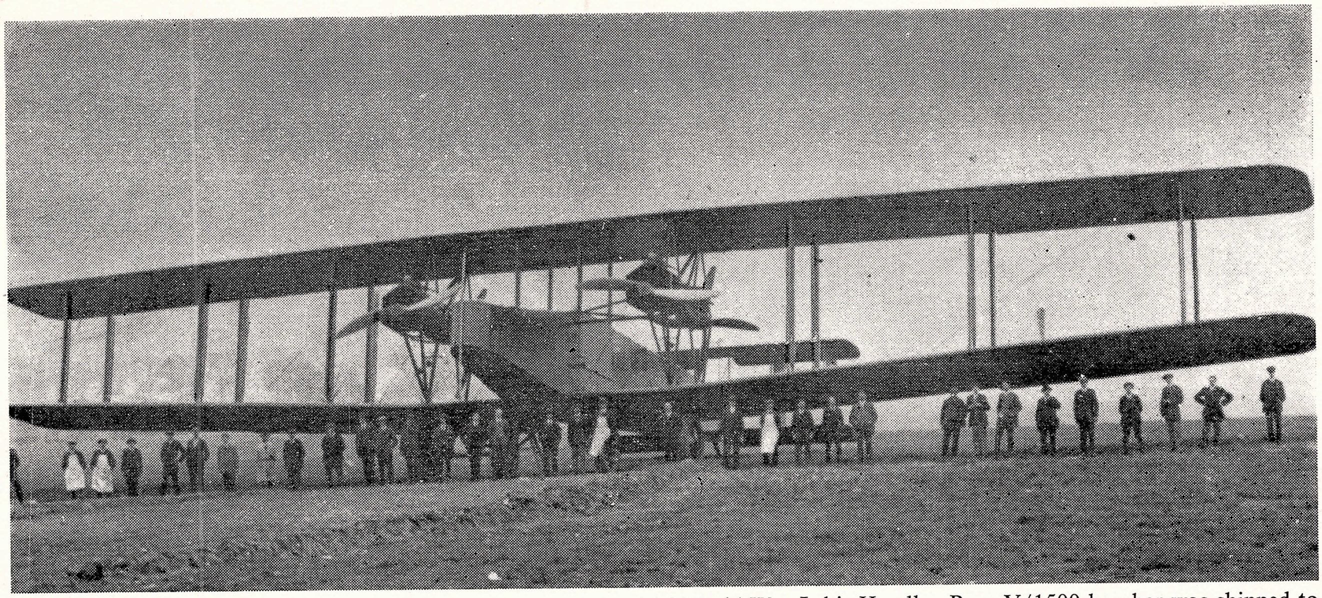


DESIGNED for the purpose of bombing Berlin toward the end of World War I this Handley Page V/1500 bomber was shipped to Newfoundland in 1919 for a transAtlantic attempt by Stedman and his colleagues. Cheated of its first aim by the armistice, the plane's Atlantic attempt was also thwarted by the success of Alcock and Brown flying a British Vickers Vimy bomber.

50 Years of Flight

From Boxkite to Jet

Memoirs of Canada's former Air Member for Research and Development

By A/V/M E. W. Stedman

My first connection with aviation in Canada was in 1919 when I landed in Newfoundland to participate in the preparation for the projected Trans-Atlantic flights.

In 1913 the Daily Mail had offered a prize of $10,000 for the first non-stop flight across the Atlantic and this offer was repeated after the 1914-18 war. At that time calculations indicated that such a non-stop flight was just possible. A following wind would greatly increase the chance of success, but a stiff head wind could prove fatal.

These considerations led most of the competitors to plan a West to East flight. They therefore took ship to Newfoundland, in the spring of 1919, where they selected various take-off sites and proceeded to erect and tune up their planes. First to arrive were the Martinsyde and Sopwith entries.

The Martinsyde machine was a single biplane with a Rolls-Royce "Falcon" engine. The pilot was F. P. Raynham and the navigator Commander C. W. F. Morgan, R.N. This entry selected a site on the north side of Quidi Vidi Lake and by the middle of May, the machine was already erected, had been test flown and was awaiting weather suitable for the Atlantic flight.

The take-off strip had been leveled and several ditches filled in, but one ditch near the end of the strip was not filled. This ditch was the cause of the failure to take off on May 18 when the undercarriage of the aeroplane collapsed just before it was airborne.

The Sopwith machine was also a single engined biplane with a Rolls-Royce "Eagle" engine. The pilot was Harry Hawker and the navigator was Lt.-Commander Grieve, RN. This machine had the fairing of the tail end of the fuselage made in the form of a small boat. It also had provision for jettisoning the undercarriage after take-off. (This was done in the event and the recovered undercarriage is now in the St. John's museum.) The take-off point for this entry was at Mount Pearl, but I did not have an opportunity to visit them and so have no personal knowledge of the conditions under which they were operating.

Hawker Disappeared

On May 18, Hawker, having received favorable weather reports, decided to take off. It should be remembered that at this time machines were heavily loaded for their power; they had thin wings with no flaps; the take-off strips were improvised grass strips, not particularly level, soft in spots and having one direction only, so that the take-off was one of the hazards. Hawker dropped his undercarriage soon after take-off.

Then he disappeared! The world was held in suspense. No word was received of the machine and it did not arrive in Europe.

After hope had been almost exhausted it was learned that the machine was forced down at sea and had been picked up by the SS Mary. The ship had no wireless and so was unable to transmit the news. Cause of the failure was overheating of the engine due to a change in the installation and not due to any mechanical defect in the engine itself.

The relief felt by the other competitors, when the news of the rescue was received, can be imagined. This episode also attracted the attention of the whole world and focused interest on the remaining entries.

The Handley Page entry, with which I was associated, was a four-engined biplane of the V 1500 type, designed for long range bombing and particularly for the attack on Berlin.

This aircraft had a wing span of 126 feet. The engines were arranged in two nacelles each housing two Rolls-Royce "Eagle" engines mounted back to back. The front engines drove tractor propellers and the rear engines powered pusher propellers.

Full-load weight for the Atlantic

Air Vice-Marshal Ernest W. Stedman, CB, OBE, M.I.C.E., F.R.Ae.S., F.I.A.S., Hon.F.C.A.I., was born in England. After an engineering apprenticeship he studied at the Royal College of Science and City Guilds College in London. Following two years industry experience he was appointed a Junior Assistant on the scientific staff in aeronautics at the National Physical Laboratory, in 1913. During the First War he served as technical officer in the Royal Naval Air Service and Royal Air Force, attaining the rank of Lt. Col., RAF. He was then made chief of the technical staff at Messrs. Handley Page and came to Canada in 1919 in connection with H-P V-1500 aircraft's attempt at the first trans-Atlantic flight. He returned to Canada permanently in 1920. AVM Stedman served initially as Director of the Technical Branch of the Air Board and entered the Royal Canadian Air Force on its organization. He retired from the RCAF in 1946, his last post being Air Member for Research and Development. For two years he was Air Adviser to the Chairman of the Defense Research Board, and for seven years Assistant Professor of Engineering at Carleton College, Ottawa. He died in 1957.

flight would be about 32,000 lb. if full tanks were used. The 2,000 gallons of fuel which could be carried was estimated to be sufficient for about 30 hours' flying. Take-off with this fuel load would be possible only under very favorable conditions, more probable load would be 1,700 gallons, allowing for something over 24 hours' cruising. With 1,600 miles to cover in this time, a cruising speed of 65 m.p.h. was required. This seemed reasonable, taking into account that every little bit of favorable wind would give a greater degree of safety.

The crew was to consist of Herbert Brackley, DSO, as first pilot; Mark Kerr, as second pilot and publicity officer; Major T. Gran as navigator and stand-by pilot; and Mr. F. Wyatt as wireless operator.

Brackley had a distinguished career as a pilot and commanding officer of a Handley Page bombing squadron during the war. Mark Kerr, after long service in the Royal Navy, also served during the war in the Royal Air Force and in the Tank Corps.

Gran, a Norwegian, served in the Royal Air Force during the war and previously had been a member of the Scott Antarctic Expedition. Wyatt was an experienced ship wireless officer.

I was in charge of the general organization of the expedition and also all the ground work.

Geoffrey Taylor (now Sir Geoffrey Ingram Taylor, MA, FRS) was the meteorologist. He had had experience of North Atlantic weather on the ice patrol vessels and was of considerable value to all, as will be explained later.

Mr. R. H. White of the Marconi Company was in charge of our wireless equipment. The installations were unique in that they included direction finding apparatus using aerials looped spanwise and lengthwise of the machine.

We had an exceptionally good team of mechanics under Mr. R. W. Petch, who had served with me during most of the war on Handley Page bombers. They were A. P. Arnold, B. F. Beech, J. J. Baird, C. C. Clements, R. Clark of Rolls-Royce Ltd., J. Donaldson, G. C. Essam, A. Harold, J. W. Stoten, J. A. Watling and G. G. Yates.

Lt. Robin Reid, RAF, son of Mr. Robert Reid of the Reid Newfoundland Company, formed the advance party and had selected and cleared a take-off strip at Harbour Grace prior to our arrival. The foresight of our company in arranging for the construction of this airstrip by local people who knew the country is emphasized when we read of the difficulties experienced by other competitors.

On my arrival I issued a cheque for about $25,000 for work carried out in preparation of the airstrip, which included moving a house, cutting down woods, removing walls and then leveling, etc.

Tree-Brushing Take-off

Before leaving England a take-off with approximately full load was made to determine a figure for take-off distance. From this, estimates could be made for the take-off distance with different loads. This heavy load take-off was accomplished at Cricklewood, and afterwards some repairs were necessary to the lower ailerons, which had been damaged by contact with the tops of the trees at the edge of the aerodrome!

This test gave us confidence that the take-off could be accomplished under favorable conditions in the approximately 900 yards available at Harbour Grace.

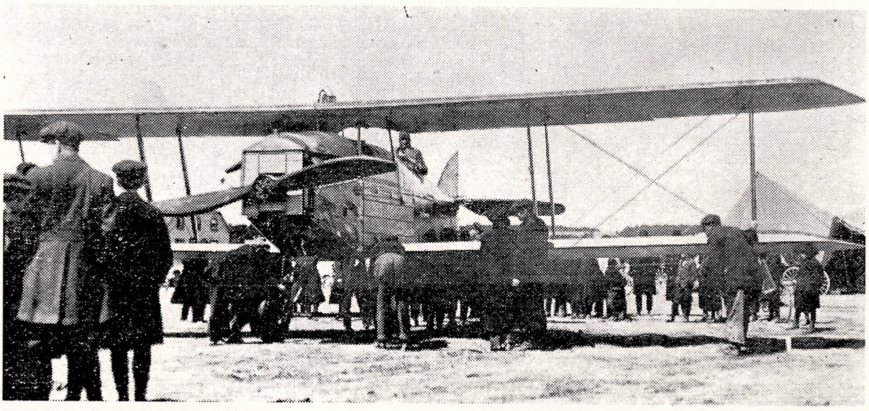
During these trials there was some indication of overheating of the engines. This was disturbing because it was not possible to increase the radiator surface in the time available. It was decided to go ahead with the radiators that we had, hoping that the cooler air (?) of Newfoundland would assist. In the meantime the company at home was to investigate the radiator problem.

The aeroplane, which was the largest in Britain at that time, was packed in a number of large packing cases and sent by road to Liverpool. The overseas crew did the dismantling and packing since they were the ones who would be required to re-erect the machine. A list of the contents of each packing case was made.

This proved of great value because on the way to Liverpool one of the larger cases was wrecked by coming into contact with a bridge. There was no time to bring the parts back to London for repair, and so a duplicate case of parts was prepared and sent to Liverpool just in time to catch the boat.

The party sailed from Liverpool on May 2, 1919, on the SS Digby of the Furness Withy Line (Capt. Chambers, RNR). The six packing cases containing the wings and fuselage, too large for the hatches, were carried as deck cargo. The fuselage case was carried athwart ship, overlapping the rail on each side. Luckily no bad weather was experienced. We arrived at St. John's, Newfoundland, on May 10.

The unloading with the lifting gear available was rather difficult and we were fortunate in having no mishaps. Although we later found a damaged longeron, there was no way of knowing when or how this occurred. It did, however, indicate the necessity for building large packing cases of this kind so that the deformation, when



FIRST CONTENDER for the British Daily Mail's $10,000 transAtlantic prize to arrive in Newfoundland was this Martinsyde biplane, with Rolls-Royce Falcon engine.

INGENUITY was one of the first requisites of pioneer flying attempts. Here, the H.P. V/1500's landing gear is being used to transport one of the large cases containing parts of the aircraft from the railway siding to the assembly area.

supported in various and unexpected way, will be a minimum.

The cases were transported by a special freight train to Harbour Grace. At one point it was necessary to unload the wing cases, slide them along the rails under a bridge and reload them on the flat cars.

At Harbour Grace the railway siding was about half a mile from the take-off strip. The cases had to be unloaded from the flat cars without any lifting tackle and then transported down a rough road to the field.

It was soon realized that the shipment itself contained the best equipment for moving the cases. And so the first thing to be unpacked was the undercarriage. The wheels and the axles, with the addition of some telegraph poles, made an excellent and easily handled trolley for moving the large cases. Once again the list of contents came in useful for we knew exactly where to go to find the undercarriage.

At this point I should like to pay tribute to the value of the work performed by the local men employed to load and unload the train. They were very resourceful, showing us how heavy loads could be slid off flat cars by building up cribs with railway ties. These men were frequently called in to assist and were always most helpful and willing.

By May 16 the equipment had been moved to the field and unpacked. It was at this time that we found the broken longeron in the rear-end of the fuselage.

Repairs In The Field

These longerons were McGruer struts made in the form of a tube about four inches in diameter by rolling spruce veneer over a mandrel. The method of repair was to cut out the damaged portion (about three feet long) and make a circular solid spruce piece to fit snugly into the interior of the hollow longeron at each end. To obtain a long glued joint it was necessary to make the insert slide a long way into one end of the hollow longeron before inserting it into the other end and sliding it into position.

It was a beautiful piece of woodwork carried out under very difficult conditions by Mr. J. Donaldson. At the joints, steel straps were placed around the longeron and the insert and straps connected by steel ties to provide for tension in the joint.

I had some qualms about this repair because of the very heavy loads and shocks that occurred in the lower longerons during taxying with full load. They proved to be unfounded, due to the excellent workmanship. After the first heavy load flight we all forgot about the repair. All the work done in the field was under the expert supervision of Mr. R. W. Petch.

I have a photograph dated May 18 which shows the erection of a gantry to lift the fuselage for fitting of the undercarriage. A note under the photo says that it was raining. The engine nacelles were in position by the 19th and on the 21st the longeron repair was finished.

It was during this time that Raynham and Hawker made their attempts as already mentioned. Also Capt. V. S. Bennett, representing the Boulton and Paul entry, had arrived and was negotiating for the use of our take-off strip at Harbour Grace. Later, this group started to erect a canvas hangar at the field, but it was not completed nor had their aircraft arrived when we left some weeks later.

Interest now seemed to concentrate on our machine. Raynham and Hawker had shot their bow; the Boulton and Paul machine had not arrived. Our machine was approaching completion and could possibly get away before the Vickers entry which was due to arrive on May 24.

We were too busy to go to Trepassey to see the American N.C. flying boats which had arrived and were preparing for the flight to Europe via the Azores. Our news of them was confined to that obtained from the local papers.

The aeroplane was lifted to fit the undercarriage on May 24 and soon afterwards the engines were lifted into position. The next task was to erect the wings. Handling these huge surfaces in the open air was particularly difficult. Especially so at this time as a gale started, necessitating erection of a canvas-strip wind-break on high poles.

With great difficulty the wings, struts and flying wires were put into position so that the machine was comparatively safe. It was then turned head to wind, securely tied down and left to weather out the gale which lasted another two days.

It was June 3 before we had weather that was suitable for trueing up the wings in the open. Our first trial flight took place June 10 with light load.

Our estimate had been that we should be ready for flight in about a month. This proved to be correct, in spite of the unforeseen circumstances.

About this time we had a visit from Mr. Platford of Messrs. Rolls-Royce Ltd., and were able to benefit from his examination of the engine installation. One of the items requiring his approval was extemporized bonding of all the ignition wiring done by wrapping gauze around the wires. The aim was to improve wireless reception.

Justice Was Postponed

Our first trial flight happened to be on a day on which the local court was sitting in the Court House overlooking our flying field. It was told that as soon as we started to run the engines the court adjourned and everyone went outside to sit on the fence and see the show. Justice was dispensed with for the moment and the court resumed its duties when there were no interesting distractions.

The overheating problem showed again. It seemed unsafe to let the machine start under these conditions because full power would be required for several hours after take-off.

Quite recently Brackley's log has been published. It indicates that the crew were of the same opinion. Subsequent events demonstrated that the decision to delay probably saved the lives of four brave men. A weakness in the design of the engine installation, which on a later flight caused a forced landing, was undetected at the time of our preparations for the Atlantic.

Cables to and from England had

indicated that flow tests had revealed defects in manufacture in radiators of the type that we were using. New radiators had been despatched from England and we were held up awaiting their arrival.

In the meantime the Vickers entry had arrived and was erected at Quidi Vidi near St. John's. Later the machine was transferred to the Ropewalk.

The Vickers "Vimy" was a twin-engined biplane with two Rolls-Royce "Eagle" engines. It was ready for flight by June 12, about the time we decided it would be unwise to continue with our present radiators. Details of the Vickers entry are well covered by Wallace's recently published book, "The Flight of Alcock and Brown."

Our meteorologist, Geoffrey Taylor, was situated in St. John's where he could have access to all meteorological information and consult with the Air Ministry meteorologists. He rang me up one night to say that he had detected a meteorological condition developing that would indicate strong tail winds all across the Atlantic.

If our machine was ready, it should take off!

But if, as he understood, we could not start, he asked permission to give the information to Alcock and Brown of the Vickers Group. Capt. John Alcock was pilot of the entry and Lt. A. W. Brown was the navigator.

Permission to pass the weather information on was readily given, because our machine could not profit by it. The result is well known.

The Vimy Successful

Alcock and Brown flew the Atlantic on June 14, 1919, in appalling weather, but with the very necessary tail wind. They landed in Ireland at 8.40 GMT after about 16 hours' flying. Both secured knighthoods in recognition of their bravery.

Our party contributed to this magnificent performance in another way also. The official instrument for measuring the altitude of stars was a special form of sextant which used the back and forward horizons to provide a level from which to measure angles. Gran found this instrument awkward to handle under cramped conditions in the air. He doubted whether it could be used in the difficulties likely to be experienced.

The device he designed for overcoming the problem consisted of two small Abney levels, fitted with a battery and small light so that the bubble was just visible. He intended to carry one of these units for use if the more accurate but complicated instrument proved to be unmanageable.

Gran told me that just before Alcock and Brown took off he handed one of these Abney levels to Brown. Some years later I was told (without confirmation) that the only sight taken by Brown on the flight was taken with this Abney level.

The successful flight by Alcock and Brown was a great triumph for aviation. It confirmed the faith which dedicated pioneers placed in the future of air transport. But there was still some distance to go. It was some years before anyone made a successful flight from East to West and several were lost in the attempt.

The success of the Vickers "Vimy" entry did not bring an immediate halt to our endeavors.

The new radiators were installed on the Handley Page without delay and on June 18, a flight was made with a load of 1,100 gallons of fuel and six passengers. The radiators were reported satisfactory and the crew were confident the machine was ready for the trans-Atlantic flight. Our party now awaited instructions from London.

The questions that arose were: Did the crew wish to continue now that the prize and the honor of being the first to fly the Atlantic had been won by Alcock and Brown? Were our sponsors prepared to sanction a belated trans-Atlantic flight with all the risk involved and little to be gained?

The answer was supplied by cables from London instructing us to organize a non-stop flight to New York for publicity purposes.

No Mean Proposal

Looking back after 37 years, and in the light of subsequent experience, I cannot but wonder at the equanimity with which we accepted the proposal that we should organize a nonstop flight of about 1,100 miles over country about which the crew had no knowledge.

We are by now so accustomed to thinking of prepared runways, alternate landing fields, aids to navigation, etc. that it is hard to appreciate that at the time about which I am writing these did not exist. Once a machine had left the ground the pilot had to depend almost entirely upon his own resources and ability to complete the flight safely.

The projected flight to New York started on the evening of July 4. The crew consisted of Brackely, Kerr, Gran and Wyatt (the original crew) with the addition of Arnold as engineer and Clements as rigger. These extra passengers could be carried because the full fuel load was not necessary or desirable, since it would involve serious take-off risks.

The events during this flight are best recorded by extracts from Brackley's log.

"July 5, 5.55 p.m. Splendid get off in 340 yards down hill. Weather: thick fog banks just off aerodrome and far out to sea only 2/300 ft. thick. Weather otherwise v. good. Revs. 1800.1720.1800.1820. Temp. 78 deg. throughout.

6.03 Height 1,000 ft. Returned over aerodrome. Course 230 deg.

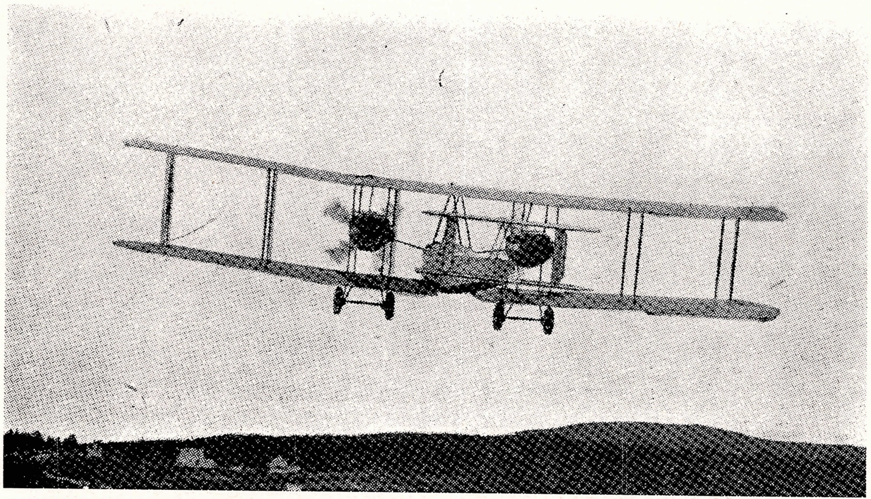
6.15 2,000 ft.

6.40 2,500 ft. Got direction of Glace Bay. Sending and receiving sets working well. Weather: Blue sky, light clouds, low fog banks near woods.

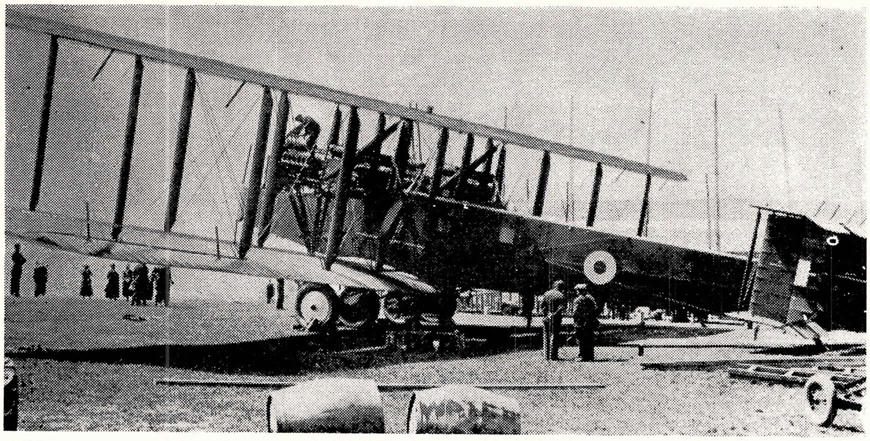
7.00 3,000 ft. Just over clouds and over sea. All going well, but climb v. slow. Temp. 80 deg., 79 deg., 79 deg., 83 deg.

7.40 3,000 ft. Port fore engine syphoning. Temp. 78 deg. Gran got excellent sight with sextant. Wind on sea S.W. v. light. Smoke bomb dropped.

7.45 Height 2,900 ft. Port fore and stbd. rear boiling. Passing over St. Miquelon Northern Point. Port fore



VICKERS VIMY taking off from Newfoundland on the first successful transAtlantic flight on June 14, 1919, manned by Capt. John Alcock and Lieut. A. W. Brown.



ASSEMBLED and trued-up at Harbour Grace, Newfoundland, the Handley Page is seen here being readied for a test flight. Engine overheating delayed a record attempt.

and stbd. rear throttled down slightly.

7.53 Height 2,800 ft. Passing W. edge of Miquelon. 135 knots from Harbour Grace averaging 73 knots p.h.

8.20 Height 2,700 ft. Kerr relieved me at wheel. Course 275 deg. Gran took another good sight.

10.20 I relieved Admiral. Altered course to 270 deg. We are averaging 72 knots. SW. winds getting stronger. Temperature rising. Atmosphere very warm. Thermometer registering 70 deg. Fah.

10.25 Passed over town. Lights show up well, rather hazy.

10.45 Gran took control. Everythink okay. Engines warming up too much.

11.30 Port fore and stbd. rear temp. 92 deg. Height 2,200 ft.

11.40 Admiral took over. Course altered to 260 deg. Very warm. Fuselage fabric rubbing holes near rear tank. Clements busy lacing up.

12.30 a.m. I took over. Engine very hot.

12.45 Something adrift on stbd. fore engine. Arnold climbed out; could not locate trouble, oil pouring out from somewhere, exhaust too bright to see from pilot's seat.

1.30 Admiral took over, height 2,000 ft. v. hilly country, temp. v. high. Stbd. front engine going groggy; oil pipe is adrift; cannot last much longer; other engines v. hot.

2.05 I took over. Stbd. front engine conked. Con. rod came through crank case — made large hole. Height 1,500 ft., over very hilly country, very dark, can only see tops of hills. Nearly ran into side of hill; side slipped to avoid. Altered course to N. by W. in order to strike coast. Gran and Arnold climbed out twice. Gran fixed up instrument board which had come adrift.

2.15 Picked up lights of town on coast.

2.45 Over lights of town. Very dark, could not distinguish nature of ground, country still very hilly. Height only 1,400 ft. Circled round until dawn. Found we were over small town. Chose field, looked like race track, came down to 500 ft., looked good, circled round again and shut off. Just missed two fences at edge of track, landed all right, then ran on to another fence. Ground full of hummocks; put on engines and tried to clear fence. Nothing doing! Struck nasty dump and stbd. outer wheel crumpled and swung us round to right, near some small trees.

5.45 Machine turned on its nose. Gran jumped clear. Admiral and I slid out. Throttles were jammed open as we crashed; had to switch off. People rushed up to our aid but no one was hurt. Wyatt, Arnold and Clements had been sent to rear of machine soon after engine conked."

Began Airfield Campaign

This dramatic description of a flight over unknown country at a time when there were no prepared landing fields speaks for itself. The failure occurred at 2.05 a.m. and in spite of the overheating of the other engines the machine flew until 5.45 a.m. In that time it could have reached any suitable field within a range of 200 miles or more if such had been available. W. H. Dennis (later Senator Dennis), of the Halifax "Herald," realized some of the problems facing anyone who undertook to fly in Nova Scotia at that time and started a campaign for an aerodrome in or near Halifax. (Halifax "Herald," July 15th, 1919).

There is a discrepancy between the date given in Brackley's log and that in my own notes which give the date as July 4. But there seems no doubt that the start was made on the evening of July 4 and the landing on the morning of July 5.

An article in the Halifax "Herald," published on Monday, July 7, as quoted below speaks of the machine leaving Harbour Grace on Friday and crashing on Saturday morning.

I recollect also that the night the machine left Harbour Grace we stayed on the airfield all night and periodically sent up rockets to guide the machine to the field if it should be forced to return. This watch was maintained until we knew fuel was exhausted and there was no chance of return. The people of Harbour Grace thought we were celebrating the Fourth of July.

The landing was made at Parrsboro N. S. The main reason for its selection was that having noticed the lights of the town, the crew decided it was best to stay near known habitation rather than continuing over unknown country.

Extracts from the account of an interview with the crew from the Halifax "Herald" of July 7 are as follows:

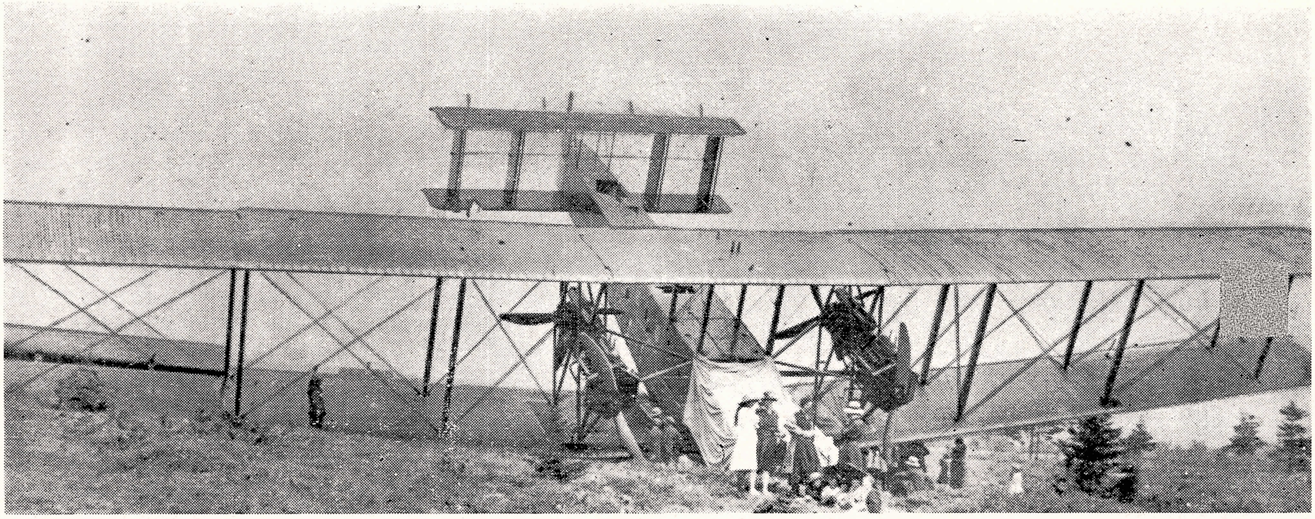
"PARRSBORO, July 6. The giant Handley Page 'Atlantic,' originally built to bomb Berlin crashed beside a buckwheat patch here; and in a house nearby I found her crew of six eating out their stoic hearts in a vain endeavour to keep chagrin and disappointment from showing through a veneer of typical English reserve and bold-heartedness.

"The machine is the biggest thing in the way of a bombing plane ever to come out from a factory — a bit of oil-feed pipe broken by the terrific vibration, was the sole cause of it alighting here.

"The Atlantic took off on her thousand mile flight from Harbour Grace, Newfoundland, to Mineola, New York at six o'clock Friday evening. She crashed at Parrsboro on Saturday morning, after cruising the area, at an altitude of 2,000 feet for three and a half hours, looking for a suitable landing ground."

"The Atlantic had been making a successful flight for hours, at an average speed of about 90 miles. At 12.30 o'clock, midnight, her pilot detected the first trouble in a reduction of speed in the forward starboard engine, which dropped to 1,600 revolutions a minute.

"And right there was recorded a feat that for splendid daring has few equals in the history of aeronautics. Major Gran and Engineer Arnold twice crawled out through a skylight, along the top of the machine, and up to the engines suspended above, in an endeavour to locate the trouble. The fierce heat of the exhaust handicapped their efforts greatly, and it was pitch dark. Had the trouble occurred in daylight Admiral Kerr is certain that it could have been remedied. Major



SAD ENDING to the Handley Page V-1500's flight from Harbour Grace, Newfoundland, to New York, came when a forced landing had to be made in a field at Parrsboro, Nova Scotia. The machine was repaired on the spot and continued on its way.

Gran and his companion succeeded in ascertaining the cause of the trouble, but they could not locate the seat of it. They felt the drip of oil—and knew what that meant. It meant that the oil intended for the crippled engine was running to waste—also it meant that the machine could not continue.

"A consultation was held; and the decision was to make a landing. In her crippled state, the great plane could not get up beyond 2,000 feet—and such altitude would simply mean disaster among fog and mountains. So the cruise for a landing ground began."

"While there are many features of this broken flight that demand prominent mention, none will take supersedence over the fact that on the Atlantic was being carried out a highly important experiment in wireless telegraphy; for the first time the directional compass was being used on an aeroplane. Directional wireless had been used during the war from land stations; and by this means exact locations of enemy ships were determined, solely by picking up their messages by different stations and arriving at the locations by angle calculation. In the case of the Atlantic's experiment the idea was reversed; the plane navigating by means of locations calculated from message picked up by her own apparatus. The experiment met with highly satisfactory results." (Extract ends.)

The cause of the forced landing was found to be the failure of the joint between an oil-pipe and the tank. The method of jointing the copper pipe to the tank was to expand the end of the pipe to form a flange and then rivet the flange to the tank. That such a joint would be approved seems unbelievable today. If the pipe vibrated at all it was only a matter of time before failure occurred.

I doubt if such a joint would have been approved even at that time if it had been given any consideration but I suspect that it was made in a hurry during the rush to get the machine on to the ship. However, I am writing about the early days of aviation before we had learned many of the possible causes of failure. Many things done then would not be accepted today.

My ground crew and I, still at Harbour Grace, received the news in a telegram from the crew, which said they had crashed at Parrsboro, N.S. and that, in their opinion, *this was better than dropping into the Atlantic.* If the Atlantic flight had been attempted, even with the best of radiators, this same oil pipe failure would probably have occurred, at about the same flying time, dropping them into the middle of the ocean.

Engines Were Impeccable

The performance of the Rolls-Royce engines during this flight and in fact during all the flights that I have discussed, was so outstanding that we never had any doubt about the running of the engines themselves.

From the reported damage to the plane, the Handley Page company decided to carry out repairs and continue with the proposed visit to New York. Some of my mechanics now decided they wanted to go home direct from St. John's. The remainder, six mechanics and myself, with tools and such parts as we had, including a spare engine, travelling by train and boat from St. John's to Parrsboro.

The first of my duties was to inspect the machine and size up the problem of rebuilding it in the open air as it was much too large to be handled in any local building.

The only experienced aircraft mechanics available were the eight that were with us. A list of all the parts required, including a new nose portion of the fuselage, lower wing, underearrriage, propeller, etc. was cabled to England.

The next question was where the machine could take-off after being repaired. It was desirable that the repair should be done in a field from which the plane could be flown.

The forced landing had been made in a race-course, which looked good from the air. The track itself, in fact, was quite good but the space inside the track was rough. It is probable that in better light conditions a successful landing could have been made on the straight portion of the track. Actually the landing was across the centre of the field and the roughness caused the undercarriage failure.

We decided the machine could be rebuilt where it was and that after repair it could be towed by the tractor we had brought from Newfoundland to the straight portion of the racetrack. A flight with light load could be made from the track with the aircraft landing immediately afterwards in an adjacent field which was suitable for a loaded take-off.

The machine was now put into position for rebuilding and the damaged parts removed. The new parts arrived at Halifax on S.S. "Caterino" around August 21st and were shipped by rail to Parrsboro, where once again the handling of the large packing cases without adequate lifting tackle presented its problems.

The rebuilding problem was largely a repetition of the work done at Harbour Grace. A gantry was erected for lifting the machine, the critical point being when the machine was hanging from the gantry and all the supports cleared away underneath to make room for fitting the undercarriage.

Previous experience had taught me

that as we lifted we should block up underneath with as little clear space as possible. It was well that this was done because when the machine was nearly up to the required height the cross pole on the gantry broke at a hidden knot. A new pole was rigged and the undercarriage was fitted without further incident.

The most difficult was the fabric work. The lower centre plane and the fuselage had to be recovered and doped in the open air. It was now near the end of September and even with such heating as could be improvised, doping could be successfully carried out only when the sun was shining. The slightest cloud and the dope began to blush and doping had to cease.

During the rebuilding we removed one of the large fuel tanks from the original bomb bay of the fuselage to make room for passenger accommodation.

The machine was re-erected by October 1st. The next day it was towed to the racetrack and then flown off with a light load. The landing was made in Crossman's larger field which was nearby.

After one or two trial flights it was decided that October 9 should be the date for the flight to Long Island N.Y.

Passengers Carried

It is interesting that although most of the local people had not seen an airplane before this one crashed almost in their back yards they nearly all wanted to ride as passengers during these trial flights. We were only able to take a few.

The people of Nova Scotia, and of Parrsboro in particular, had displayed the greatest kindness to us all. In fact it was the kindness of the people with whom we made contact and the vision of the possible future for aviation in Canada, that resulted in my return to this country.

The passengers for the flight to New York were Mr. Martin of the New York "Herald"; Mr. Sears, motion picture operator; A. D. Merkel, Halifax manager of the Canadian Press; W. H. Dennis, General Manager of the Halifax "Herald"; and five mechanics. Major Brackley was pilot and Admiral Mark Kerr co-pilot. Gran and Wyatt had returned to England soon after the machine arrived at Parrsboro.

Starting Problems

The morning of October 9 proved bright but frosty. Three engines started quickly but the fourth refused to start.

It was most annoying that with three engines running none of the some 1,000 horsepower they were capable of producing could be applied to starting the fourth engine. It had to be cranked by hand, a heart-breaking process. In this case it was a question of getting heat into the system by heating water and thawing things out with hot cloths. This delayed the start till about 11 a.m., a very unfortunate development.

The plane landed at Greenport L.I., short of its objective, at about 11 p.m. after encountering head winds. This night landing, without any ground facilities, was a magnificent piece of piloting.

The flight was described by Mr. Martin in the New York "Herald" of October 12, 1919. Incidentally, this was a world's record for passenger carrying at that time but it was not recognized because it had not been officially observed.

After three days of bad weather the machine flew to Mitchell Field L.I. Many groups of passengers, about 30 at a time, were carried from Mitchell field.

As a further demonstration of the benefits of air transport, and the capabilities of the H-P machine in particular, arrangements were made to embark a load of American Railway Express packages for carriage to Chicago.

The aircraft never reached Chicago. First, there was a forced landing at Mount Jewett, Pa. Later, when landing to refuel at Cleveland, the crew brought the plane down on a race track instead of at the Glen Martin airfield. The error was the result of a mistake in directions.

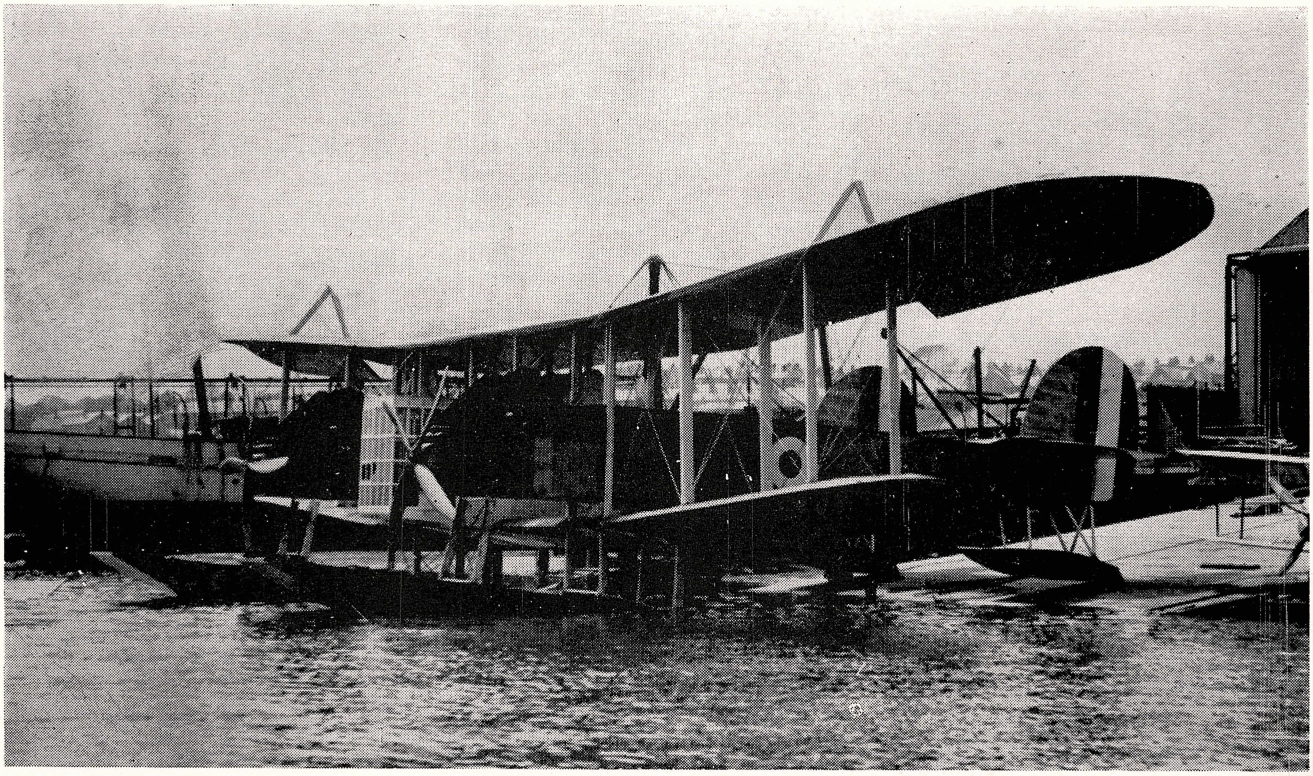
Despite the fact that they were coming in at the wrong place, the crew pulled off an acceptable landing. However, they found themselves suddenly confronted by grandstands at the side of the field. The space between the stands was just a little less than the wing span of the aircraft. As a result, the tips of the wings were damaged when the pilot was forced to attempt to complete his landing run by going between the stands.

Many Aids Needed

It was now the end of November and we all wanted to get back to England. We had learned a great deal about the difficulties of civilian flying. We realized that there was much to be done particularly with respect to aids to aerial navigation before civil aviation could be expected to succeed.

The decision was that the aircraft would not be repaired at that time, and that we would all return to England.

The machine could have been repaired easily for only the wings were damaged and there were plenty of spare wings available in England among war surplus stocks. The reason it was not repaired at a later date was no doubt the fact that a bomber does not usually lend itself to conversion to a satisfactory passenger-carrying airplane.



FIRST TYPE 1000 seaplane on the slipway of J. Samuel White, at Cowes, Isle of Wight. Armor plate and huge Triplex plate glass crew compartment were designed as protection against ground rifle fire. Type had 12-pounder gun for attacks on shipping.

From Boxkite to Jet

Early Trials—and Tribulations

Seaplanes that wouldn't unstick — Bombs that wouldn't drop

By A/V/M E. W. Stedman

During my early training as an engineer — before the First World War — I became at least mildly interested in aviation.

Many incidents that I recall contributed to this interest: The airship "Nulli Secundus" had flown over London from Farnborough. Bleriot's monoplane was exhibited in Selfridge's department store following his successful flight across the English Channel. And while I was a student at the Royal College of Science — taking a three-year course in mechanics and mathematics — I witnessed one of the earliest flights by an aeroplane in England.

I was walking along the sea-wall at Sheerness, in Kent, when the aircraft — a Wright type biplane — flew past me, quite low. It went as far as the mouth of the River Medway, then turned and flew back in the direction of Sheerness, where much of the early flying in Britain was undertaken.

It was after four years of practical training in an engineering shop that I attended the Royal College of Science and then spent a final year in civil and mechanical engineering at the City Guilds College. I began my working career on engineering sales at Messrs. Sturtevant Engineering Co. in London in 1912, and then early in 1913 I was invited by a friend to visit the National Physical Laboratory. There I saw wind tunnel experiments being performed and realized that this was pioneer work, never before attempted.

That night there were some far-reaching discussions in our household. My wife's consent was necessary for the step that I contemplated. With her blessing I applied for a position on the scientific staff in aeronautics at the National Physical Laboratory.

I became a junior scientific assistant at a salary only a fraction of that I had been receiving. The main consideration in making this change was the great satisfaction I felt in doing pioneering work.

But it also offered an opportunity for more home life, doing away with the hour's train journey night and morning between the suburbs and the City. The year spent at the NPL was a very happy one for both my wife and I.

Early Flap Experiments

One of my early recollections at the Laboratory was of the tests made with J. L. Naylor of a plane with a hinged rear portion, i.e., an aileron. The results gave us information for speculating upon the possibilities of using a variable camber for an aeroplane wing and the effect of a flap in increasing lift.

During this year (1913) I had my first flight, at the Royal Aircraft Factory at Farnborough, in an RE type machine which had been prepared for an attempt on an altitude record. The height achieved shortly afterwards was about 19,000 feet.

In common with all young people at that time my future was completely changed by the advent of the First World War.

Dr. Glazebrook, head of the NPL, had been in touch with the Admiralty who required engineers for the Royal Naval Air Service. He also had a request from the War Office for engineers for work at the Royal Aircraft Factory.

Service With The Navy

As the result of previous contact with the Royal Navy, I was more interested in the RNAS. Consequently, with Francis Bramwell, who had also offered his services from the NPL, I transferred to the Air Department of the Admiralty with the rank of Lieutenant, RNVR, attached RNAS.

The design branch of the Air Department of the Admiralty, when we reported for duty, consisted of Harris Booth, who was in charge, and Harold Bolas. It was soon increased by the addition of others, many of whom have since become well known in aviation circles: Buchanan, Hume, Pippard, Pritchard, Tinson, Watts, etc.

We immediately set to work on the design of a seaplane known as the Type No. 1,000.

At this time the German Navy was shut up in Kiel Harbor and would not come out. This type of seaplane was intended to be flown over Kiel and attack the German fleet with gunfire from overhead, where the ships enjoyed the minimum of armament protection.

The first article of this serialized story, taken from the memoirs of the late Air Vice-Marshal Ernest W. Stedman, appeared in the January issue of Canadian Aviation and dealt with his first connections with aviation in Canada. This month's excerpt is in the nature of a flashback — to the author's early career in Britain and First War experiences. A/V/M Stedman lived in Canada for most of his life, and at the time of his retirement from the RCAF was Air Member for Research and Development.

It was a biplane, with overhang on the top plane, and had two fuselages, each carrying a 225-hp Sunbeam engine and a central nacelle in which was fitted another Sunbeam engine driving a pusher airscrew. This nacelle also carried a 12-pounder naval gun and the crew. Under each fuselage there was a large main float and also a tail float, i.e., four floats in all.

My own contribution was to investigate the design of the floats. They were square in cross section and of what was then called the "Short" type, in which the heel of the float acted as the step.

Sea Level Ceiling!

I do not know how much of my original design was used by the manufacturer but I am pleased that during the subsequent history of the machine the floats did not develop any weaknesses. This in spite of the terrific pounding that they received due to the fact that the machine was designed to fly virtually at sea level when fully loaded, gaining height only as fuel was consumed, and the all-up weight reduced.

I well recall my first flight in one of these machines from Newhaven Bay, in 1916.

We had expected to be off before we had crossed the bay but it was obvious that we required much more space. So the pilot John Seddon turned towards the rougher water in the English Channel where we bounced from wave-crest to wave-crest until after a seemingly interminable period we appeared to be airborne. The log gives the time during take off as two minutes.

Our orders were that we were to circle Folkestone Pier and wait for a flashing light signal before proceeding further. When we reached Folkestone, which is about 60 miles from Newhaven, we were at about 200 feet, or less than two wing spans. But it seemed as though we were just over the masts of the ships, and circling was impossible.

I climbed up to the top of the nacelle, which had been left open for the trials at the request of the pilot, and signalled to the pier and they gave us the signal to go ahead.

Went Around Cliffs

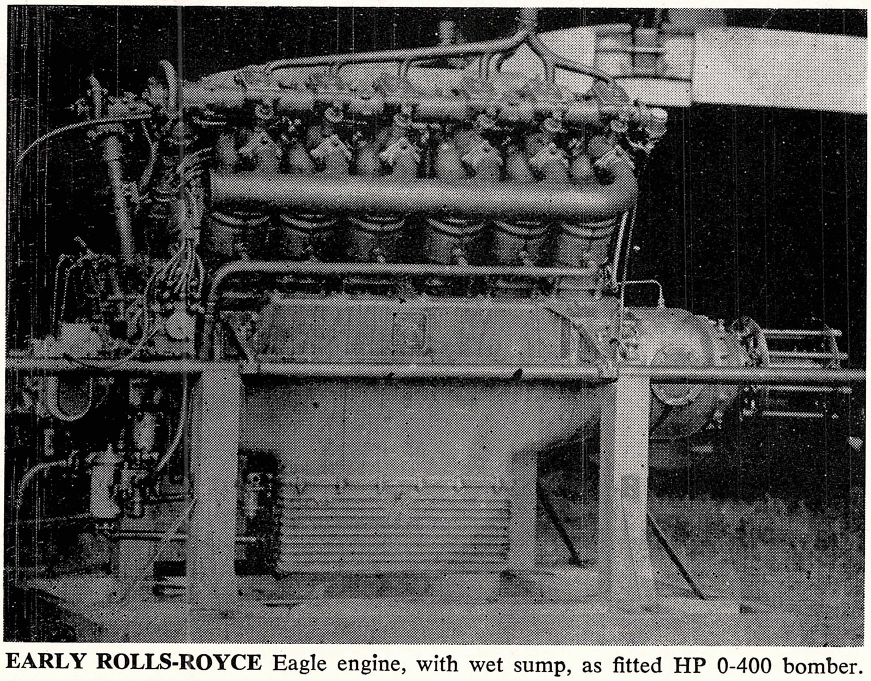
We had hoped to cut across part of Kent but by the time we reached Thanet we were just about level with the top of the cliffs and so had to go all around the North Foreland. We then headed across the Thames Estuary and reached a height of 400 feet.

After a short time John Seddon indicated that he could smell gasoline and so we opened a small door to inspect the engine nacelle.

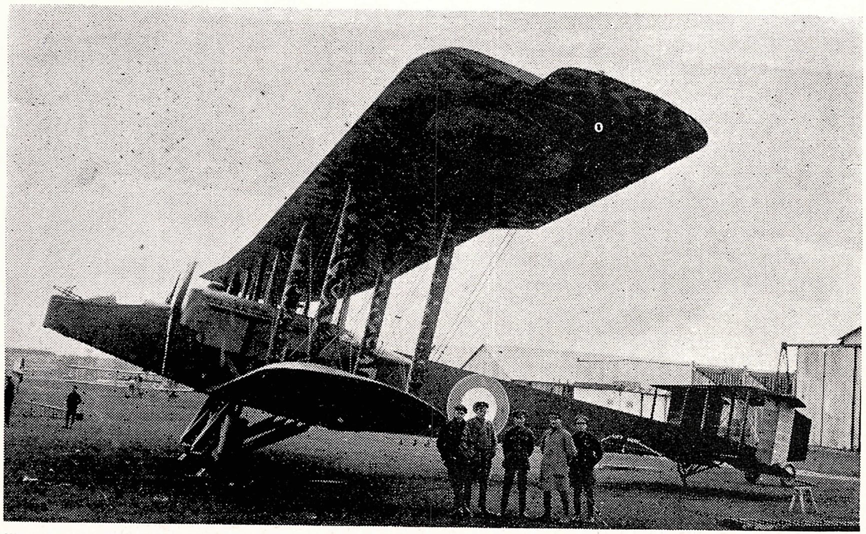
We found that a fuel pipe had fractured and was pouring gasoline over the engine, which was immediately shut down. With this loss of power we could no longer maintain height and we were forced down on to the surface of the water, being rescued by lifeboat some hours later.

By the spring of 1915 I had tired of office work and asked to be moved outside with the result that I was posted to the factory of Messrs. Vickers, at Crayford in Kent, as resident inspector for the Admiralty.

This company had an order for the Vickers Gun Bus, as it was called,



EARLY ROLLS-ROYCE Eagle engine, with wet sump, as fitted HP 0-400 bomber.



HP 0-400 BOMBER at Ochey, in France, and a group of officers with the author in the centre. Ornate camouflage earned the name "Le Tigre" from a "hostile" French anti-aircraft battery, which apparently refused to recognize the machine as an ally.

a pusher type biplane with a "Monosoupape" Gnome engine of about 100 horsepower. The wings were of the usual wood and fabric construction, but the nacelle was made from thin steel tubing. The undercarriage had two skids.

The machine was designed to carry a Vickers gun in the front of the nacelle. There was a crew of two, pilot and gunner.

Twice during 1915 I was sent to France to report on aircraft. In May I went to Paris to report on the FBA flying boat, a light boat fitted with a Gnome engine and having a plywood hull. We were interested in a light flying boat and some very good ones were designed later in England.

In September I was sent to St. Omer to inspect a German Albatros that had been captured.

Towards the end of the year I was assigned to make periodic inspection trips to several factories where experimental aircraft were being built.

HP Bomber Trials

In December, 1915, I was detailed to act as the technical observer for the type trials of the Handley Page 0-400 Bomber, with John Babington (Air Marshal Sir John Tremayne KCB, CBE, DSO, RAF retired) as pilot.

This was about the largest land plane in existence at that time, with the possible exception of a Sikorsky plane in Russia. It was designed to have a totally enclosed pilot's cockpit and to be armored against rifle fire.

After some six months of exhaustive testing, during which a number of problems were met and overcome, we were convinced that we had in the HP 0-400 a very valuable bomber. When sufficient machines were available we were taken off test flying and sent to Manston, Kent, to form the first Handley Page Squadron. John Babington was the Commanding Officer and I was his engineer officer. This was in July, 1916.

In September the squadron was ordered to No. 3 Wing, RNAS, at Luxeuil, France. The first machine was to be flown there by John Babington. I went along with Jimmy Jones, one of the first pilots posted to the squadron, and Paul Bewsher, his observer. Two of our best mechanics, Abbott and Cradock, were also carried. Jones and Bewsher were to take over the machine upon arrival and Babington and I were to return to Manston.

We had no difficulty during the trip to Paris. But on the stage from Paris to Luxeuil, over the foothills of the Vosges Mountains, both engines cut due to magneto failure. John Babington landed the machine down hill in a field that had a jog in it about half way down, a fine effort.

We were near a small town named Vauvillers in Haute Saone, about 30 miles from our destination. After repairs and with a lightened machine John Babington flew out of the same field. The agreement was that if we had reached a speed of 30 mph by the time we reached the jog in the field it would be safe to go ahead. It only took us a few minutes to reach Luxeuil.

Present For Jerry!

We returned to Manston to supervise the despatch of the other machines but in the meantime another crew, leaving soon after us, had become lost and landed behind the lines, thus presenting the Germans with one of our new machines.

During the next few months I spent a good deal of time helping to get the machines with their inexperienced crews to Luxeuil. In December 1916 I was posted there myself.

In March, 1917, we moved from Luxeuil to Ochey which was an advanced aerodrome from which most of the bombing by No. 3 Wing was carried out. The machines in use were mostly the Sopwith 1½ Strutter. The majority of the pilots and observers were Canadians.

Trial Bombing Raid

We had not tried out one of our Handley Page machines over the lines and had never carried a full load of bombs. It was therefore decided that John Babington, as pilot, I as observer, a French observer named Chazard who knew the district, and one of our observers named Hains as rear gunner, should carry out a raid on the iron works at Hagendingen, a few miles up the Moselle Valley, north of Metz.

We had a full load of sixteen 112-lb bombs in the new type racks in which the bombs were slung, nose up, inside the fuselage. The opening in the bottom of the fuselage was converted by spring loaded doors which were supposed to be pushed open by the bombs as they fell.

As we approached Metz, Chazard said there was mist rising in the valleys, that we should not be able to see our target and that probably it would cover our own aerodrome before we got back if we stayed out too long. He recommended we should attack our alternative target, the railway yards at Metz.

We reached the alternative target but the bombs, when released, fell a few inches then stuck in the bomb doors. Hains and I had to jettison the bombs as best we could by putting all our weight on them to push them through the doors. They appeared to fall in open fields.

The bomb doors were removed before any more raids were attempted and a heavy piece of brown paper, pasted over the opening, took their place. The bombs burst through the paper when released.

Early on the return journey we saw that the people at our aerodrome had also seen the rising fog and had set up a large fire for our guidance, visible from the air for miles around.

A squadron of Handley Page bombers had been allocated to the Independent Air Force, under General Trenchard (the late Viscount Trenchard, GCM, OM, GCVO, RAF), and was stationed at Ochey. There was

CANADIAN PILOTS and observers flew these Sopwith 1½ Strutters at Ochey, in 1917. They were used as bombers, with only pilot, and as fighters, with a crew of two.

some difficulty in keeping the machines serviceable and so I was lent to assist in getting their machines into shape.

The RBAS at Dunkirk operated a repair depot which early in 1918 was badly bombed with the result that it was transferred to Guines, near Calais, where it was less liable to attack. Soon after this transfer I was appointed Commanding Officer of this depot, known as No. 4 ASD. It was an appointment which was very interesting during this period when the Germans were pulling out of Belgium with a continual call for all the aeroplanes that we could supply.

Berlin Attack Plan

Shortly before the Armistice the Independent Air Force prepared some of the new Handley Page V-1500 bombers for an attack on Berlin. They were to operate from an aerodrome at Bircham Newton.

The Handley Page V-1500 was a biplane of 126 feet span with top and bottom planes equal. It had four Rolls-Royce Eagle engines arranged in two nacelles, one on each side of the fuselage, and each containing a pusher and a tractor engine. There was no cowling over the engines, a sacrifice of cleanliness made to reduce weight.

The machine had a crew of six, and carried thirty 250-lb bombs for short raids, but a smaller load over longer distances. It carried 1,000 gallons of fuel giving about 12 hours maximum endurance, and perhaps 1,200 miles range. I was sent to Bircham Newton to assist with the preparation of these bombers.

When I arrived there were three bombers available. This was on November 8, 1918. The next day we had three machines out on the tarmac, fully loaded, standing by to leave for Berlin. Word came through later that the order would not be given that day. Rolls Royce representatives then said that they wanted to change all the four engines in one of the machines. We worked all night on this.

The next morning the machines were again out on the tarmac ready to go if ordered and the experience of the previous day was repeated. That night we changed the engines in another machine.

On the 11th the machines were ready again. Then came news that the armistice had been signed and the war was at an end. I did not see any of the celebrations. I went to bed for the first time in several days.

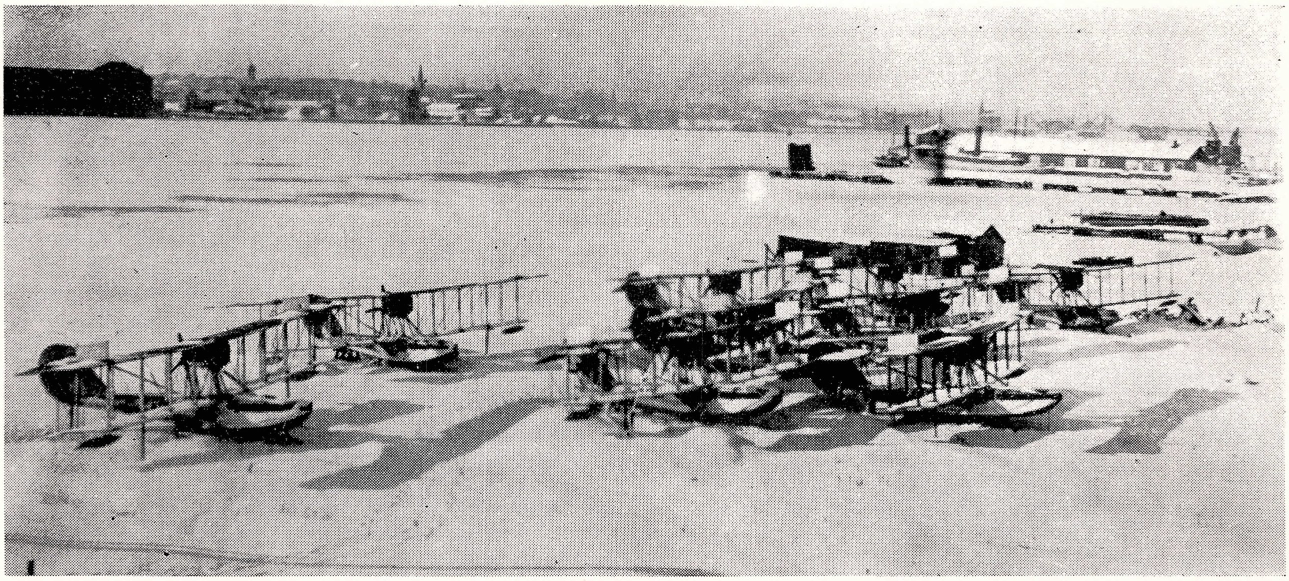
After the armistice I was posted to the Air Ministry and then in April 1919 I joined Messrs. Handley Page as chief of the technical staff.

At about this time research began on the slotted wing. Handley Page (later Sir Frederick Handley Page C.B.E.) had conceived the idea that by cutting a spanwise slot in an aerofoil the lift could be increased.

This was confirmed by tests in the firm's wind tunnel, conducted by Geoffrey Hill (the late Prof. G. T. R. Hill, MC) who was also test pilot. An experimental full scale set of wings was made for a DH9 which was also tested by Geoffrey Hill. The results led to patents being taken out in the principal countries of the world.

Soon after I joined Handley Page the proposal was put forward that one of the V-1500 bombers should be used to compete for the Daily Mail Prize, offered for the first flight across the Atlantic.

It was in connection with this proposed transAtlantic attempt, to be made from Newfoundland, that I first visited Canada.



EARLY VEHICLES of the Canadian Air Board were these HS2L flying boats resting from forestry operations, Sault Ste. Marie.

From Boxkite to Jet

Catering for Early Air Needs

By A/V/M E. W. Stedman

My experiences and associations in Newfoundland in connection with the Handley Page entry in the Daily Mail's TransAtlantic Flight competition of 1919 led to the return of my wife and I to Canada in the following year.

I believed that Canada was a country admirably suited to the development of the aviation industry. Both its physical characteristics, with vast distances to be conquered, and the venturesome pioneer spirit of those of its people with whom I came into contact, convinced me that in Canada the air age would be an era rich in challenge and adventure.

My intention was to open a small shop producing sheet metal products with the object of making airplane parts as the aircraft industry developed.

Things rarely work out as planned. Shortly after my arrival in Canada the Air Board, which had just been formed, advertised for a Director of the Technical Branch. The qualifications required were exactly those I possessed. I was given the appointment on October 30, 1920.

The Air Board, which I was to serve as Technical Branch Director, was created on June 6, 1919, by an Act of the Canadian Parliament. The duties of its members were to supervise all matters connected with aeronautics; to study the development of aeronautics in Canada and other countries; to undertake such technical research as might be requisite for the development of aeronautics, and to co-operate with other institutions in carrying out such research.

The Board was also required to control all government aerodromes, aircraft and services, to examine all proposals for commercial air services, and prepare for approval by the Governor in Council such regulations as might be considered necessary for the control and operation of aeronautics in Canada.

Research Implemented

To implement the requirements for fostering scientific research, an Associate Air Research Committee was formed under the Honorary Advisory Council for Scientific and Industrial Research. The first meeting was held on February 7, 1920. Members of the committee were Prof. A. S. Eve, Professor of Physics at McGill University, who was chairman; R. J. Durley, Secretary of the Engineering Standards Association, who acted as secretary; Prof. J. C. McLennan, Professor of Physics at the University of Toronto; and J. H. Parkin, Lecturer in Applied Science at the University of Toronto.

Shortly after its establishment, the Air Board took over seaplane stations erected during the war at Halifax and Sydney, N.S., and the aerodrome at Camp Borden. Also the British Government turned over to the Board a great deal of surplus equipment which was just beginning to arrive at the time I took up my appointment.

The Air Board Report for 1921 indicated changes in the composition of the Board and the addition of a Technical Directorate under my supervision. Duties of this directorate are listed as:

(1) Calculations to determine the stability and strength of construction, with a view to ascertaining the airworthiness of commercial aeroplanes.

(2) Draft of specifications for all materials used in aircraft, in co-operation with the Canadian Engineering Standards Association.

(3) Inspection and testing of materials purchased by the Air Board.

(4) Design of a flying boat adapted to conditions peculiar to Canada.

(5) Examination of aircraft and engines.

Many problems confronted us in the establishment of aviation in Canada.

The first and most important was the nature of the terrain over which we had to work. There were few aerodromes available, none of them in the northern regions where much work had to be done.

On the other hand there were numerous lakes suitable for use by flying boats or float planes during summer and ski planes during winter.

The airplanes available were mostly land planes designed in Europe or the U. S., and some flying boats of rather unwieldy types. This meant that every type of land plane brought in had to be equipped to take floats and skis. These requirements alone called for many structural alterations, all of which had to be checked for airworthiness.

Climatic Problems

In addition, our climate was much more severe than that in the country of origin, with wide ranges of temperature between winter and summer. This presented problems not only with the operation of the engine but in the structure itself and in the protection of the occupants.

These considerations indicate why we were interested in producing aircraft that, from the start, had been designed to do the work for which they were required, under the climatic conditions likely to be experienced. The policy of the Air Board was to encourage the manufacture of as much of our equipment as possible by our own industry.

Flying operations were carried out at Halifax, N.S.; Roberval, Que.; Ottawa and Camp Borden, Ont.; Morley, Alta.; and Vancouver, B.C., with the HS-2L flying boat in general use at the seaplane stations. There were also a few F-3 flying boats in use.

Our first undertaking with these boats was to make them conform to airworthiness specifications by modifications to the wings. We also equipped them for vertical and oblique photography.

At Ottawa and Camp Borden the main problem for our division was the solution of the difficulties that arose during winter flying. In the First War, the Curtiss JN-4 trainers had been flown from Canada with skis, but, in the main, Royal Flying Corps training had been continued during the winter months by moving to Texas. We now had to face up to the problem of flying with safety all year round.

The mchines in use were the Avro 504K, DH-9a, DH-4, and Sopwith Camel. We were making improvements in our equipment to overcome difficulties that arose. Air-cooled engines did not cause too much trouble, but the operation of large liquid-cooled engines such as the Liberty and the Rolls Royce Eagle, was another matter.

By 1922 operations had extended into Manitoba (Victoria Beach, The Pas and Norway House). Morley, Alta., had been replaced by High River and forest protection was carried out in Ontario from Parry Sound and Whitney using HS-2L flying boats.

One of the first airworthiness jobs we undertook was the stressing of the HS-2L flying boat, many of which were in use by the Air Board and others, to determine whether it met civil airworthiness requirements.

Investigation showed that at one time in the design the wing span had been increased by adding a six-foot bay on each side. The spars in this extra bay were of the same cross section as the original spars. Calculations indicated new spars were necessary.

Oliver Adams (Group Captain A. O. Adams, OBE, CD, retired) and Claude Gliddon, both young engineers who were among the first to join the Air Board staff, worked on this analysis.

I recall that new spars for the six-foot sections of the planes for all the HS-2L flying boats we had in service were made under the supervision of "Bob" Ford (W/C R. G. Ford, retired) in a workshop that we rented on Sparks Street in Ottawa.

For aircraft designed in other countries with which we had a working agreement the certificates issued by the parent country could generally be accepted. But there were always modifications to suit Canadian conditions, such as the fitting of floats or skis, which had to be checked locally.

Many specifications for aircraft materials issued by the British Air Ministry during the war were available for our guidance. With the assistance of the Canadian Engineering Standards Association these were quickly adapted to suit our conditions.

Independent Inspection

Early in 1922 steps were taken to establish an Aircraft Inspection Department which would undertake the inspection of parts during or after manufacture. It was required that personnel in this department did not come under the control of the shops engaged in the production. In other words, we felt that independent inspection was necessary.

This was the first postwar provision for an AID, which has always done such valuable service. It was started at Camp Borden in January, 1922. The first officer appointed was A. L. Johnson (the late A/C A. L. Johnson, CBE) who had similar experience with the AID in England and whose good sense and ability did a great deal to establish this branch.

The AID was also required to make periodical inspections of civil aircraft for renewing certificates of airworthiness. But after some time it was found that sufficient experienced inspectors were available outside. We then adopted the system of approved inspectors employed by the various companies.

The original AID at Camp Borden comprised one officer and two NCOs, viz.: A. L. Johnson, J. B. Boyd (Group Captain retired) and W. J. Gregson.

It was the co-operation and support given by men of this calibre that made my work so interesting and satisfying.

In using the words "original AID" in the above description, I may have given the impression that this was the first AID in Canada. In fact the British AID was responsible for the inspection of aircraft and engines built in Canada during the First War.

Flying Boat Design

Detailed requirements for the flying boat, tailored to meet conditions encountered in Canada, were collected and a specification was prepared in 1922. This specification was sent out to manufacturers with a call for tenders for eight amphibian flying boats, to be built in Canada.

The aircraft was to carry a pilot and four passengers, at a cruising speed of 80 mph, with a duration of six hours flying and a working ceiling of not less than 12,000 feet.

The contract was let to Canadian Vickers of Montreal for the construction of six machines of the Vickers Viking type, designed in Britain. Delivery of two others of the same type, built in the English factory, was to be obtained so as to have sample machines in operation as soon as possible.

A list of the projects in hand under the auspices of the Associate Air Research Committee as given in the Air Board Report for 1922 is of interest. It indicates that from the beginning it was realized the main things Canada could contribute to aviation were related to winter flying.

The projects in hand were:

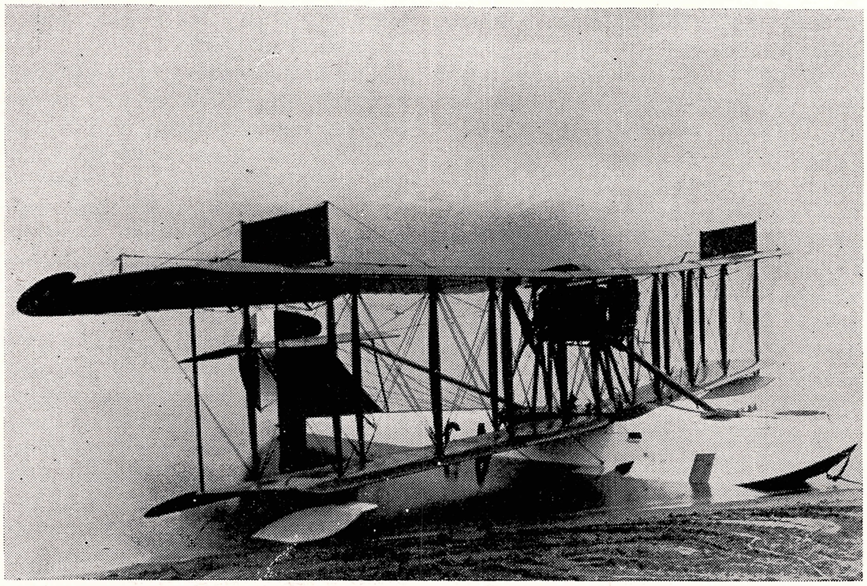
(1) Operation of aero-engines at low temperatures by Prof. C. Robb at the University of Alberta.

(2) Barograph diaphragms by Stanley Smith.

(3) Anti-freeze mixtures by Prof. McKergow of McGill University.

(4) Friction of runners on snow by C. Gliddon of McGill University.

(5) Wind tunnel tests by Prof. J.



AIRWORTHINESS TESTS carried out on the HS2L flying boat, seen here tied up at Vancouver, B.C., revealed necessity for modification to strengthen the wing spars.

H. Parkin at the University of Toronto.

(6) Storage of oil at low temperature by Prof. Bain of the University of Toronto.

(7) Low temperature effects on rigging by Prof. Gillespie at the University of Toronto.

Early Aerial Photography

A development about this time was the modification of aircraft for aerial photography. This arose initially out of the use of flying boats for forest patrols. Elwood Wilson, chief forester of the Laurentide Pulp and Paper Company, acquired two HS-2L flying boats from the federal government for this purpose.

One of these boats was, I believe, the first flying boat to be fitted for vertical photography using a "pot" type mount. This was a metal casting let into the keel of the boat at the front cockpit. It was closed by a plug when the boat was on the water. In the air the plug was removed and the camera fixed into position with the lens pointing through the hole in the centre of the mount. This type of mount was adopted for the department's flying boats (HS-2L, Viking, Vedette and Varuna) for many years.

We also designed various mounts for taking oblique photographs from the front cockpit of the Viking flying boat. The design of these mounts and many other details of the installation were largely the work of Alan Ferrier (A/V/M A. Ferrier, CB, MC, retired) who joined the Air Board in the early days and served as my right-hand man for a great many years. Much of the drafting was done by Jack Greenhalgh (F/S J. Greenhalgh, retired) who, after some previous aircraft experience, served with the department until his retirement early in the Second War.

An important function of the Air Board was to keep in touch with the developments abroad. From 1922 onward I began a series of visits to many establishments in the United States, Britain, France, and Germany.

One of the trends I observed was the increasing power of the radial engines produced in England since The First War. In the United States, the Navy was interested in an air-cooled radial engine for use on carriers and ordered one produced by Charles Lawrance: a nine-cylinder radial engine of about 200 hp.

We in Canada were also interested in air-cooled engines, for ease of operation in the winter. We followed the Lawrance development closely, and were pleased when the Wright Company acquired the Lawrance engine, which later became known as the Wright J4.

Curtiss Racer Successes

In October, 1922, I attended an Aviation Week at Detroit. The program included the Pulitzer Trophy Race, in which the first two places were taken by the Army Curtiss Racers.

The Curtiss racer appeared to me to be the first serious postwar attempt to produce an airplane which obtained its speed as the result of clean design rather than by increased power. The race was over a course of 250 kilometres, involving 15 turns around pylons. It was won by Lieut. Maughan at an average speed of 206 mph.

At the first turn around a pylon his airplane, banked nearly vertically, was seen to slip dangerously near to the ground. Lieut. Maughan afterward explained that momentarily he did not know what was happening. This was possibly the first record of a pilot blacking out.

The Curtiss Racers were particularly clean biplanes. The wings were surfaced with veneer and embodied radiators built into the lower surface of the upper wing. From these racers the American Schneider Cup seaplanes were developed, winning the Schneider Cup Race in 1923 at an average speed of 177 mph.

During the First War, Rateau, in France, had used an exhaust-driven turbo-supercharger to increase engine power at altitude. The idea was taken up in the United States by the NACA which asked the General Electric Co. to undertake development of such a supercharger. Dr. Sanford A. Moss was largely responsible for the work on this project.

There were many other workers in this field and several types of supercharger emerged. The Armstrong Siddeley Co., in England, produced a gear-driven supercharger for their Jaguar radial engine during the First War. This set the style for other radial engine superchargers.

Attention of the world was directed to supercharger developments by a high-altitude flight made by Major R. W. Schroeder in February, 1920. The venture ended happily, but spectacularly.

Oxygen Supply Failed

Major Schroeder made an attempt on the altitude record in a plane equipped with a Liberty motor fitted with an exhaust-driven supercharger He reached an altitude of about 36,000 feet when his oxygen supply failed. The machine fell out of control to a height of about 3,000 feet before the pilot regained consciousness sufficiently to control the plane and make a safe landing.

During a visit to McCook Field we were able to discuss this flight with Major Schroeder. An interesting detail was the wooden propeller designed for the project. It was of large diameter and so constructed that it would be efficient at great altitude where the air is very very thin and the engine would be using the full capacity of the supercharger. Near the ground it was not possible to use much, if any, boost in the engine because overheating would occur.

The result was that although the combination of engine and propeller was capable of taking the machine up to 36,000 feet there was some question whether it would lift the plane off the ground. The engine could turn the propeller over only slowly at ground level.

In the year 1922 our department took over the stone building on Victoria Island at Ottawa as a central repair depot for the repair and maintenance work on flying boats and seaplanes during the winter months. There was a slipway at the island suitable for our purpose and the island was conveniently situated with respect to Headquarters and Rockcliffe Air Station.

Clive Hume (S/C D. C. M. Hume, retired) was later the commanding officer of the depot. He collected a number of officers and mechanics with First War experience and established workshops which served as a training ground for new mechanics. Walter Staveley (F/L W. Staveley, retired) had charge of the woodworking shops for a number of years.

Before leaving the subject of the Air Board, I must pay tribute to the men who were associated with me at that time. It must be remembered that in this period there was little to attract professional engineers to aviation save interest in a new and challenging branch of engineering practice. Most of these men are now well known in aviation circles.

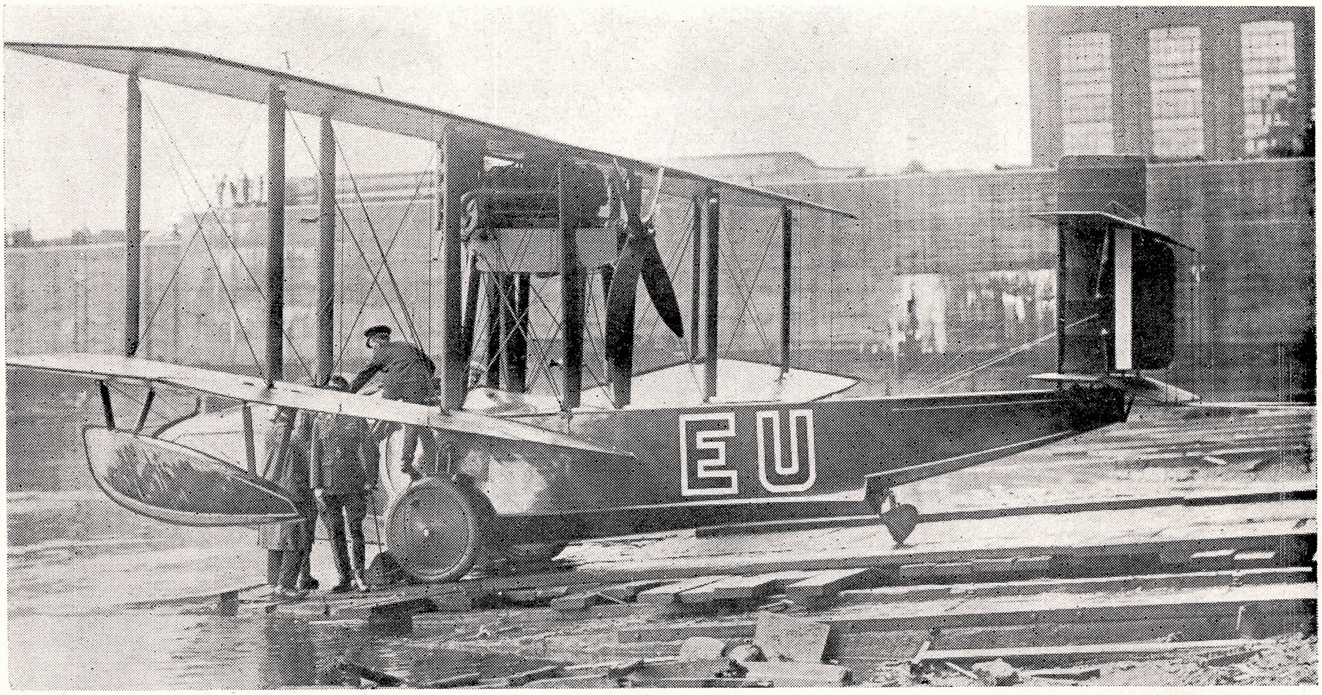
Pioneer Mechanics

The RCAF as a whole also owes a great debt to those early mechanics. Many of them had experience during the First War and it was their skill that kept our machines operating safely at a time when funds were limited. The high standard of skill they introduced was handed down to the younger men they trained.

Some of these original mechanics were still in the service when the RCAF expanded, immediately before and during the Second War period. They received recognition, and in some cases promotion to high rank. But many had left the service before there was any opportunity to give them the recognition that was their due.

Names that come to mind are Black, Boyd, Ford, Gorham, Grepson, Graham, Hems, McConnell, Moore, Rabnett and Staveley; all names that will ring a bell in the memory of those who were operating in Air Board days.

The Air Board ceased to exist as a separate department on January 1, 1923, when the Act creating the Department of National Defense came into effect. Under it the duties of the Air Board were taken over by the Minister of National Defense.



FIRST CANADIAN built Vickers Viking—the "EU"—which was launched on July 25, 1923, by the wife of G. J. Desbarats, then Deputy Minister of National Defense. Although the airplane was amphibious, the wheel gear was rarely used for landing.

From Boxkite to Jet

Laying Defense Foundations

By A/V/M E. W. Stedman

With the formation of the Department of National Defence, all air activities came under a Director CAF who reported to the Chief of the General Staff. My own position was that of Assistant Director in Charge of Supply and Research (following my two years as a Director of the Technical Branch for the Air Board).

We now considered the possibility of bringing in new blood. Hitherto all flying training had been by way of refresher courses for pilots trained during the war. There was some discussion at headquarters upon what qualifications should be required for the new recruits.

I can claim some credit for the decision that as we could give flying training to only a limited number of men, and as the Air Force was essentially a technical service, the intake should be restricted to graduates from a school of applied science or from the Royal Military College.

This FPO (Provisional Pilot Officer) training took place in the summer during the years the student was attending University. Many of them joined the permanent force upon graduation.

The decision to take only graduates resulted in an intake of very fine officers who, at the time of writing occupy the senior positions in the Royal Canadian Air Force. The first course of Provisional Pilot Officers began their training at Camp Borden in May, 1923.

In April, 1923, during a visit to the United States it was found that General William Mitchell was very interested in our work on winter flying. He was considering the possibility of flying military aircraft to Asia via Alaska, and also to Europe via the Labrador Coast and Iceland. Both of these routes were used about 20 years later.

Antidetonation Tests

An American development we watched closely concerned the detonation of aero-engines, which was beginning to worry people. Experiments were carried out in the United States with alcohol-gasoline mixtures, but these mixtures were giving trouble due to the absorption of moisture. We were also looking for antidetonation fuels and were using a mixture of benzol and gasoline.

Various forms of experimental superchargers were tried in England and the U. S. Among others I saw at Langley Field was a Roots Blower type of supercharger. It was fitted to and driven by a Liberty engine in a DHB aeroplane being tested by the N.A.C.A. This was an interesting alternative to the turbo-superchargers more generally used.

Metal propellers were being investigated at about this time. In England the ingenious Leitner-Watts propeller made from sheet metal was being developed. In the U. S. the Reed metal propeller, made by twisting a duralumin sheet into shape, was nearing commercial production. Propellers made from steel tubes by the Standard Steel Propeller Co. were being tested at McCook Field.

The DeBothezat helicopter was another development seen at McCook Field. It was powered with a BR2 air cooled engine. The machine climbed to about 10 feet but this seemed to be about its limit.

An interesting development at this time was the seat-pack parachute fitted with a pilot chute. The latter was ejected from the pack when the rip-cord was pulled and in turn pulled the main parachute out of the pack. Previously, parachutes had depended on a cord attached to the aeroplane for releasing the parachute. This cord was liable to foul parts of the aeroplane and so prevent the parachute from operating correctly.

When these parachutes were first made available their use was optional and very few people used them. Later an order was issued in the United States Army Air Force making use of parachutes compulsory for all flying personnel, resulting in the saving of many lives.

Group Captain Christie and I were both impressed with this development. We recommended to our respective headquarters that the Irving type parachute should be adopted and that its use should be made obligatory. The following year, when in England together, we were asked to go to the late Sir Hugh Trenchard's office to discuss parachutes.

Christie had arranged for a sample seat-pack type parachute to be available and with the sample on the desk in front of him we explained to Sir Hugh the points that seemed to warrant its adoption. The rip-cord was pulled causing the pilot chute to fly out. I have always felt that Christie's recommendation and our demonstration put the seat-pack type parachute into the Royal Air Force.

The six Vikings built by Canadian Vickers and the two built in England were delivered during the year 1923. The first Canadian built machine, EU, was christened in July 1923 by Mrs. Desbarats, wife of the Deputy Minister of National Defence, G. J. Desbarats CMG.

Viking EU, was tested by Lindsay Gordon (the late Air Vice Marshal J. L. Gordon, DFC) as pilot and myself as technical observer. I well remember the first landing. Just before touching down, the nose of the machine slapped quickly on to the water causing us to bounce. Gordon looked at me and said "What was that?" I did not know what the cause was and so we tried again with the same result. We found that it was the thick tail skid of the amphibian gear that touched the water first causing us to bounce.

No other machine flew with this type of tail skid. We changed the design to one having less water resistance.

A. L. Johnson had been moved from the AID at Camp Borden in 1923 to become resident inspector at the Canadian Vickers plant during the construction of the Viking aircraft. He was replaced at Camp Borden by Reg. Grant (Air Commodore R. J. Grant, retired). Johnson's experience was of great value to the company and the Department during this initial period of the establishment of a new industry.

The wheel gear of the amphibious Viking was rarely used for operation from land aerodromes. And although our records show that winter landing gear was designed for the Viking in the winter of 1923-24, I have no recollection of it ever being used. The Vikings were flown so much during the summer that most of the winter was usually spent in overhauls or modifications.

The wheel gear was very useful for ground handling. It was much better than the trolleys used for the HS2L flying boats and for the float seaplanes. It was generally removed during operations and fitted only for beaching or ground handling.

The Viking was fitted with a pot mount in the front cockpit for vertical photography, and with various types of mounts for oblique photography.

Liberty Viking Built

Drawings were prepared for a Liberty engine installation in a Viking and a prototype was made at Victoria Isand. "Bun" Shearer (the late Air Vice Marshal A. B. Shearer) and Alan Ferrier flew in it but I know nothing of its subsequent history.

The report on Civil Aviation for 1923 contains a short article that I wrote on the "Operation of Aircraft and Aircraft Engines under Winter Conditions." It dealt with a number of things that were new at that time, such as the precautions to be taken to prevent loss of anti-freeze which was then a mixture of alcohol and water, and the use of light oils to obtain easy starting. Some ideas about the design of skis were dealt with too.

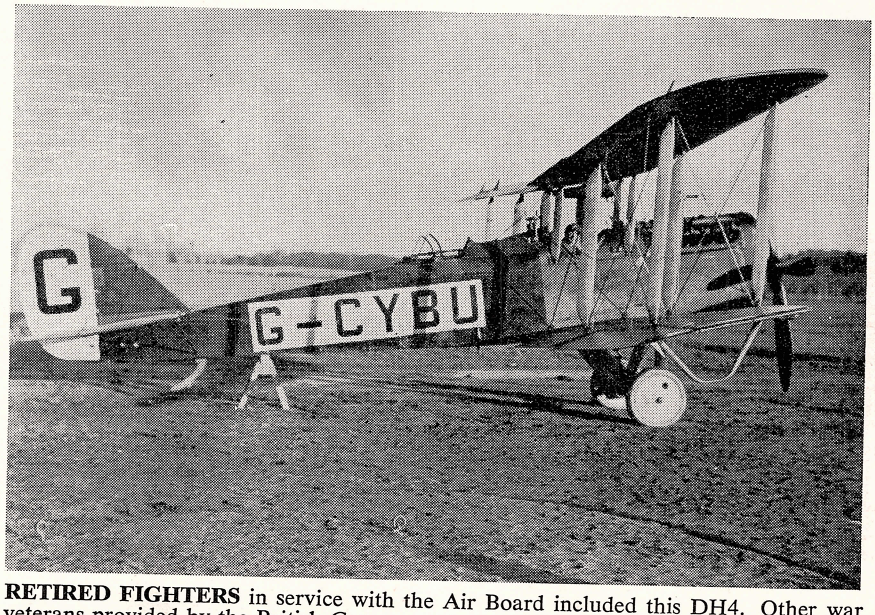
In 1923 winter flying tests were made at High River, Alberta, using the DH4 with its Rolls Royce Eagle engine. Pat Cuffe (Air Vice Marshal AAL Cuffe retired) was the Commanding Officer and Tony Rabnett (Group Captain A. A. Rabnett, M.B.E., retired) was responsible for much of the technical work.

These tests were undertaken with a definite objective. An aircraft was assumed to have landed, in midwinter, away from its base. After being moored out in the open all night, it was required that the crew be able to service it, start the engine with only the equipment carried in the aircraft, and then fly it back to base. This was no light task when large liquid-cooled engines were involved and temperatures were well below zero.

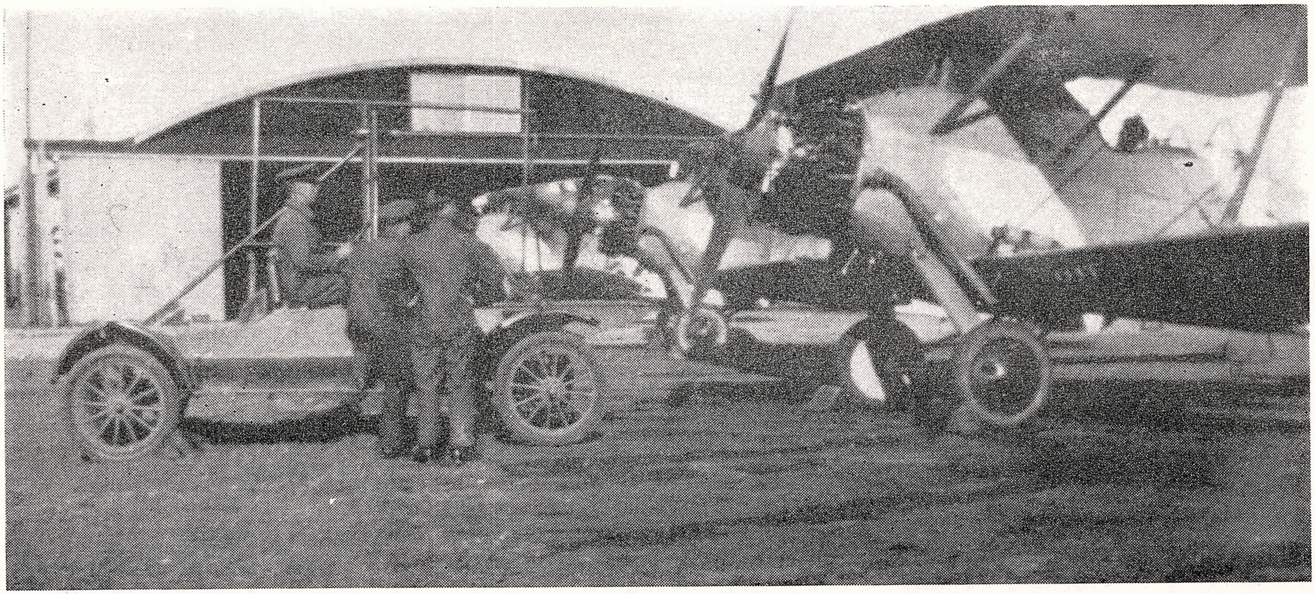
Among the problems investigated at High River was wood shrinkage. The stable moisture content of wood in Britain is much higher than that which occurs in wood in the Prairie Provinces in winter, when the temperature gets very low and the air is dry. This difference, which is quite large, resulted in the serious shrinkage of the wooden parts of aeroplanes that had been manufactured in Britain, when they were moved to stations such as High River.

Another difficulty resulted from the fact that many aeroplanes built in Britain at the end of the war had laminated wood spars. As shrinkage occurred, one lamination would shrink in one direction and an adjacent lamination would shrink in another direction, thus causing the opening up of glued joints between laminations.

This shrinkage meant that an aeroplane took some time to adjust itself to local conditions.



RETIRED FIGHTERS in service with the Air Board included this DH4. Other war veterans provided by the British Government were Avro 504K's, DH9a's and Camels.



HUCK'S STARTER was an early aid for the starting of aircraft engines. It was mounted on a Model T Ford chassis, and power from the automobile engine was transmitted to the aero engine by a dog-clutch, of adjustable height, that engaged the propeller.

Beating Winter Hazards

The starting of aero-engines under winter conditions had been a subject of particular interest to me, dating from experience with the Handley Page bombers during the First War.

We were stationed at Luxeuil near the Vosges Mountains in France during the winter of 1916-17. The weather was often very cold and difficulty was experienced in starting the water-cooled Rolls-Royce engines. We developed a trailer for the supply of hot water for the radiator, hot oil, and hot spark plugs. But hand turning was laborious and if a quick start was not obtained the warming up process had to begin all over again.

Experience in trying to start the fourth engine in the Handley Page Trans-Atlantic machine at Parrsboro, N.S., in October 1919, served to underline the problem. There could obviously be no certainty about flying on schedule until the starting problem was solved.

One of the first research projects of the newly formed Supply and Research branch was that of starting aero engines in winter, undertaken by Prof. Charlie Robb at Edmonton.

The Huck's starter had been developed in Britain at the end of the War. This consisted of a Ford Model T chassis with a power take-off which transmitted power to a horizontal shaft raised above the chassis. The height of the horizontal shaft was adjustable. This shaft had a dog-clutch at the front.

The method of use was for the chassis to be driven in front of the aeroplane and the drive clutch engaged with the propeller. The power was then engaged and the propeller could be spun using the power of the Ford engine. The switch on the aero-engine was opened and when it started to fire the clutch automatically disengaged and the chassis was backed away.

This device was quickly adopted at Canadian stations where land aircraft were in use, such as Camp Borden and High River. The starters saved a great deal of exhausting and dangerous work.

This fifth article in the series taken from the memoirs of the late Air Vice-Marshal Ernest W. Stedman, deals with the period when he was Assistant Director in charge of Supply and Research, following the formation of the Department of National Defence on January 1, 1923.

With the gift material received from England after the war there were some Bessoneau Hangars. These were canvas covered, with wooden frames of a type that had been extensively used in France. An experienced gang could erect one in a few hours.

We soon found that they would not stand up under the heavy snow loads liable to be experienced in this country. However, due to the fact that we had no money for constructing permanent hangars, we had to use them.

We decided to combine two hangars to make one by halving the distance between frames, and then covering the framing with wooden siding and ready roofing. I believe that Major Dave Barry, of the Royal Canadian Engineers, was responsible for the idea of doubling up the frames.

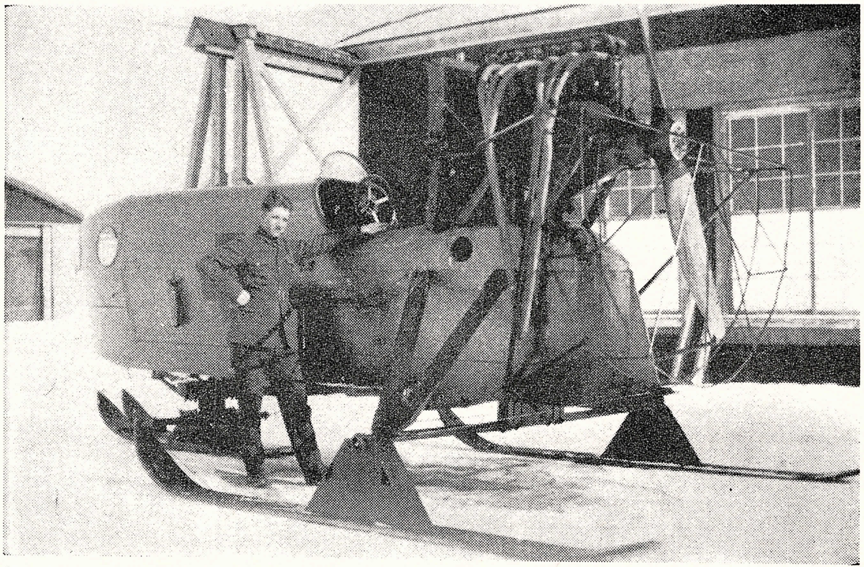
The resulting hangars stood up well but the canvas curtains (instead of doors) the earth floor and lack of heat were serious disadvantages. They were the only shelter available at that time at High River and Rockcliffe and were certainly better than nothing.

Investigations on aviation fuels also continued. The usual method of improving the knock-rating of aviation fuels was to mix benzol with the gasoline. But we soon found this to be useless in winter due to the benzol freezing. This was brought to our attention by mechanics at Camp Borden who found that if you rolled a barrel of benzol in winter you could hear the crystals moving.

Experiments with alcohol-gasoline mixtures were discontinued due to the absorption of water, and attention was now directed to the work being conducted at the General Motors research laboratory by Dr. Midgeley. The investigation appears to have started from the accidental contamination of a sample of gasoline that was being used for routine tests of knock-rating. After the addition of a small amount of iodine, this showed unusual values for the knock-rating.

This led to tests with a number of different substances, some of which showed good anti-detonation qualities. The substance that seemed to give the desired result with the minimum of additive was tetra-ethyl-lead. It was later found that it was desirable to mix the TEL with a small quantity of di-brome-ethylene.

My report on a visit with Dr. Midgeley caused a great deal of interest at the Royal Aircraft Establishment. On my visit to England in 1924 I was asked to discuss the subject at Farnborough. There I was shown a small engine under test with gasoline doped with TEL. A valve that was removed showed some corrosion, probably due to the TEL. I was of the opinion that the effect was partly due to the fact that the engine was small and running much cooler than an aero-engine so that the products of combustion were not completely volatilized.


SNOW AMBULANCE photographed at Camp Borden with LAC D. J. Miller, about 1924. It employed a blimp gondola for its body; carried two stretcher cases.

Another drawback was that TEL was toxic and therefore dangerous to handle. This objection was overcome by mixing the gasoline with the chemicals at the refinery.

Rescue Research Work

Another of our projects concerned emergency equipment for carrying out rescues or mercy missions in winter. Oliver Adams referred to the design of a propeller-driven snowmobile for Camp Borden, and Reg Collis (Air Commodore R. Collis, retired) writes:

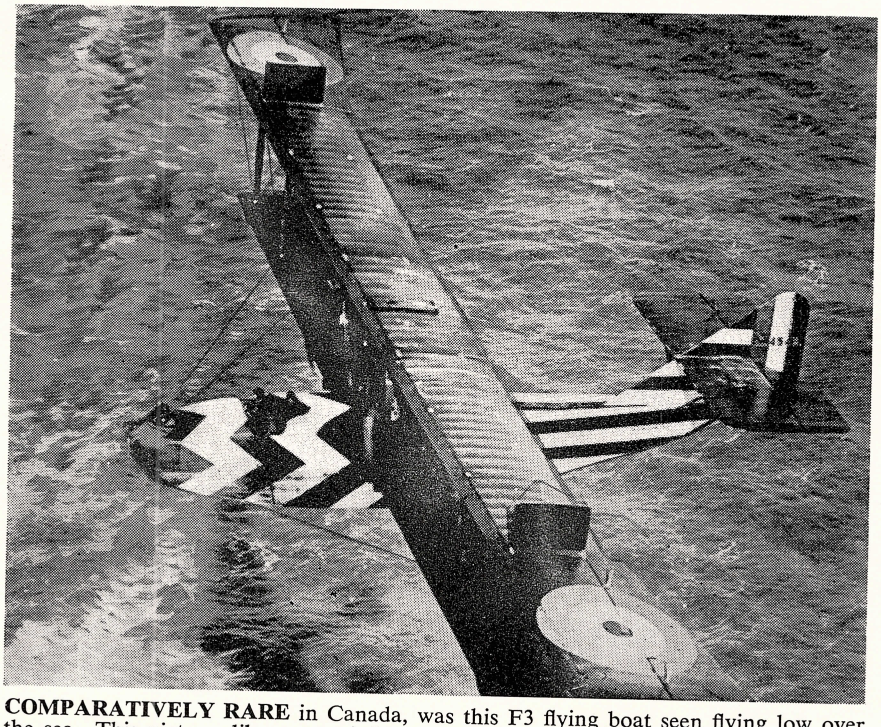
"Concerning snow ambulances — there were two types: A tractor, developed by your division, and a pusher, which was the first one and was my baby. I persuaded Col. W. Barker (CO Camp Borden) to permit me to make a two-stretcher vehicle by using the gondola of a blimp, stored in one of the hangars. This was operative during the winter of 1924. It was very satisfactory and exciting to ride on the snow-surfaced aerodrome at speeds which seemed to be much greater than they actually were."

I think that the snow ambulance illustrated is the one referred to by Reg Collis. The photos of this and the Huck starter were supplied by W.O.I. Pye, who tells me that the airman standing beside the ambulance is L.A.C. D. J. Miller (now Flight Lieutenant).

In September 1924, following a desire to produce airplanes that would be less costly to purchase and operate than the types produced as the result of war experience, the Light Aeroplane Trials were held at Lympne, England.

Object of the trials was to produce a cheap airplane for training and practice flying with an engine of not greater than 1,100-cc cylinder capacity. There was no other limitation and in some instances much smaller engines were used.

Our Department was interested because of the potential value of such an aircraft for forest patrol. It was necessary for forest observers to fly at low speeds and with a minimum of cost. I was present at the tests which demonstrated that a machine of 900 lb could fly well with an engine of this size giving something over 30 hp.


COMPARATIVELY RARE in Canada, was this F3 flying boat seen flying low over the sea. This picture, like most of the others appearing in the Boxkite to Jet series, is taken from the AVM's memoirs. No attempt at camouflage here!

VICKERS VEDETTE, first Canadian designed and manufactured flying boat, built by Canadian Vickers Ltd. Engines employed included the Rolls-Royce Falcon, then the Wright Whirlwind, and finally the Armstrong Siddeley Lynx, which became standard.

From Boxkite to Jet

Early Wind Tunnel Testing

By A/V/M E. W. Stedman

Among the pioneers in aviation in Canada with whom I was associated, was W. R. Turnbull, well known in aeronautical circles for his work on propellers. This has been described in an address to the Canadian Aeronautical Institute by John Parkin and printed in the Canadian Aeronautical Journal for January and February 1956.

Late in 1922 Mr. Turnbull wrote to the Technical Department of the Air Board asking us to carry out tests on a variable pitch propeller suitable for use on a Clerget engine. The propeller was shipped to Camp Borden and fitted to an Avro 504K biplane.

This propeller had a friction drive for changing the pitch of the blades and seemed to be a considerable advance upon propellers in use up to that time. It was given a ground test but was lost in a fire that occurred at Camp Borden.

The following is from John Parkin's paper:

"In view of the loss of the No. 1 propeller Turnbull requested the Associate Air Research Committee (of which he was an Associate) of the National Research Council on 24 December 1923 to apply to the RCAF for a grant to be used in the construction and testing of a new propeller. Turnbull proposed two alternative types of control, one by pressure of a brake shoe mounted upon the propeller and geared to the blades and the other by electric motor drive.

"The committee preferred the second method, and, a grant of $1,500 having been made by the RCAF through the committee, propeller No. 2 was designed by Turnbull in February 1925 for a somewhat obsolete aircraft and engine allocated for the tests, an Avro 504K with 130 hp Clerget engine (1,250 rpm). The propeller was constructed by Canadian Vickers Limited, and Turnbull himself made the control and indicator at Rothesay.

Performance Breakthrough

"Ground and flying tests were made at Camp Borden during June and July 1927. The results of the tests were remarkably good—quick take-off and climb, increased ceiling, and low fuel consumption at best cruising speed resulted—without back-lash or other defects.

"This propeller was not only the first controllable pitch propeller developed and tested in Canada but was the first controllable pitch propeller of its type to be tested in the world."*

At the request of the South Kensington Science Museum the propeller was first loaned in 1928 and later, in 1931, presented by Turnbull to the Museum. With the establishment of a national aeronautical museum in Ottawa by the National Research Council in 1942, the Director of the Science Museum presented the historic propeller to the Canadian Museum.

In 1917 John Parkin, who was working on other war work and also lecturing at Toronto University, had persuaded the Board of Governors of the University to provide funds for the construction of a wind-tunnel. The drawings for a four-foot National Physical Laboratory type wind-tunnel were obtained from England, the balance was purchased from the Cambridge Scientific Instrument Company, and the wind-tunnel was erected in the hydraulics laboratory of the university.

This was not the first wind tunnel in Canada. In 1902, Mr. Turnbull conducted wind-tunnel tests in a facility he had established at Rothesay, New Brunswick. However, the wind-tunnel at the University of Toronto was the only one available in Canada during the 1920's, a time when the demand for original design work tests was increasing.

In 1923 conditions in the university forced the removal of the tunnel. The Air Board offered a grant toward the erection of a suitable building to house the wind tunnel, and this was opened in February 1924.

Several improvements were incorporated in the wind tunnel before its erection in the new building. Soon afterward, the tunnel was occupied in making tests of the new airplanes being designed in Canada by Canadian Vickers.

The development of light airplanes in Europe following the Lympne trials indicated that it should be possible to design aircraft for forest patrol and other civil uses at moderate first cost and lower operating costs than those of aircraft in use at that time. A specification was prepared for a three-seater flying boat, with an air-cooled engine, to be used for forest patrol and photography.

First Canadian Plane

In 1924 Canadian Vickers engaged a design team under W. T. Reid and produced the first Canadian designed and Canadian built flying boat to the department's specification.

Known as the Vedette, the aircraft was fitted first with a Rolls Royce Falcon engine. This was later replaced by a Wright Whirlwind engine driving a pusher airscrew.

Finally, an Armstrong Siddeley Lynx engine was fitted in practically all the Vedettes used by the department.

A model of the Vedette was tested in the wind-tunnel at the University of Toronto, the first complete airplane model to be so tested in Canada.

Completion of this machine marked a step forward in the department's policy of establishing an aircraft industry in this country. The possibility of also building engines and instruments was deferred, but not lost sight of.

By the summer of 1925 the Vedette had been found satisfactory and placed in service. The wind vane on the Confederation Building in Ottawa is a model of the Vedette made from the original drawings.

Fitted for vertical and oblique photography, the Vedette remained in service for many years; the RCAF still had nine of these machines in service on April 1, 1939.

Canadian Vickers also had a contract for construction of five Avro biplanes with Viper engines for patrol of High River, where the D.H.4 biplanes in use were aging, and expensive to maintain. The Avro "Viper" planes were also later used as seaplanes for forest patrol in Manitoba.

For some months in 1924 I was attached to the AMSR Division of the Air Ministry in England and given access to all research and experimental work. The purpose was to provide the Air Member for Supply and Research, Air Vice Marshal Sir W. G. H. Salmond, with a critical report comparing the aircraft and engines available in England with those I had seen in other countries. A copy of this report is on file in the office of the air historian.

Racing Developments

The main point brought out was that the British fighters appeared to be about 30 mph slower than corresponding American machines. I indicated that the difference was probably partly due to lack of official support in speed contests in the past, and also to the continued use of radial engines which were of too great a diameter to fit into small fuselages.

On the other hand the British flying boats were ahead of anything that I had seen elsewhere.

It was obvious that, as the result of reports about American aircraft performance, official opinion was changing. It is perhaps significant that in the spring of the next year, 1925, the Air Ministry started a program of high speed development which resulted in the Supermarine Racers.

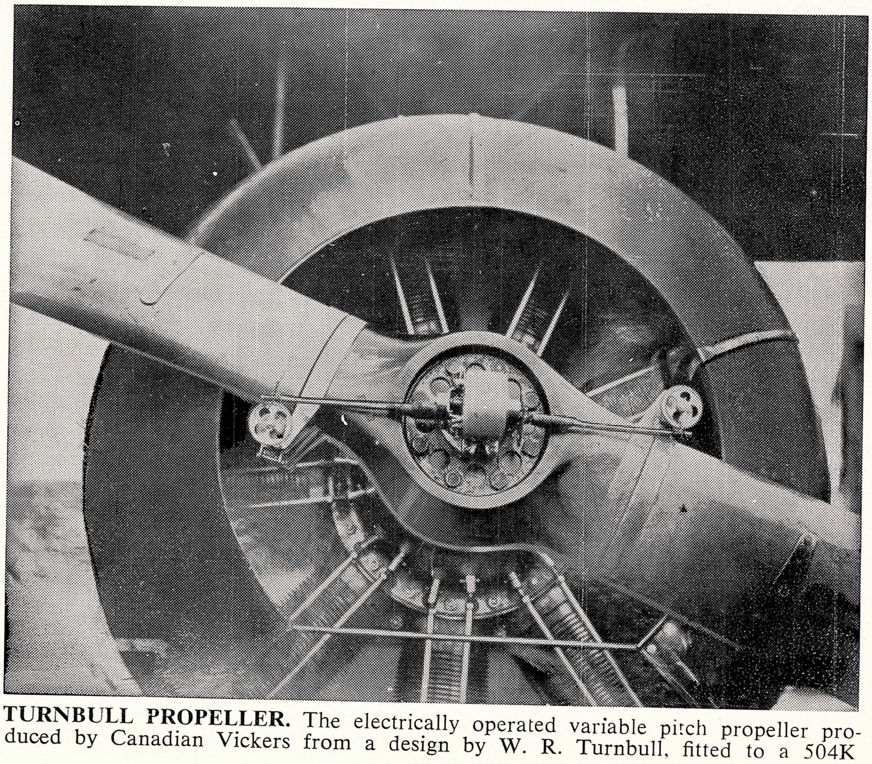
The Schneider Cup race of 1927 was won by the Supermarine S5 monoplane seaplane piloted by Webster, with a speed of 281 mph. Later, the same aircraft established a world's speed record which stood for some time.

In 1924-25 the amount of money voted for aviation in Canada was $1,300,000 of which $300,000 was for new equipment. This amount was later increased to $1,561,000, and in 1925-26 there was a further increase to $1,880,850 of which $740,850 was for new equipment.

The authorized establishment of personnel for the RCAF on April 1, 1924, was 375 officers and men. This was increased to 470 officers and men by the end of March 1925.

A new flying boat, larger than the Vedette, built by Canadian Vickers to departmental specification, for carrying fire fighting equipment was being tested in the fall of 1925. This aircraft was fitted with two air-cooled Armstrong Siddeley Lynx engines and was of wooden construction. Named the "Varuna" this was intended primarily for transportation, but like most of the department machines was fitted for photography. It gave good service until replaced by the Vancouver.

In 1925 a Mr. Myers, with the support of some Canadian associates, claimed he had master patents for all airplanes and sued Canadian Vickers for infringement of his patents. The company was not prepared to go to



TURNBULL PROPELLER. The electrically operated variable pitch propeller produced by Canadian Vickers from a design by W. R. Turnbull, fitted to a 504K

BALANCE of the wind tunnel at the University of Toronto used to test models of the Vedette, and other early Canadian Vickers seaplanes. Author thought it was still in use at the Royal Military College at Kingston, at the time of writing these memoirs.

court and so paid him a relatively small sum in settlement.

This established a precedent and gave Mr. Myers funds to continue claims against other manufacturers. At this point the department stepped in and started an action for the annulment of the patents. A prominent lawyer, W. L. Scott, K.C., was engaged to conduct the case. He was later joined by Louis Cote, K.C.

I was engaged in supplying the lawyers with technical material. It was necessary to review all the early patents in aviation to determine when certain devices had been invented.

Orville Wright Assisted

Mr. Scott and I went to Dayton to see Orville Wright to obtain from him what is called, I believe, an "Examination for Discovery." In it Mr. Wright personally described the early experiments he and his brother, Wilbur, carried out. He showed us his famous note books containing the records of their experiments. At that time this information had not been made public.

The case was tried before the Exchequer Court and the Myers patents were annulled.

In October 1925, I attended the Pulitzer Race in the United States and saw several interesting machines. The Curtiss PW8 had now given place to the P1. Hawk, a single N-strut biplane with the upper wing larger than the lower. This had a welded steel tube fuselage and was fitted with a Reed type propeller.

The wing radiator, due to its vulnerability to gun fire, was replaced by a tunnel type radiator under the engine. The Hawk had a speed of about 170 mph perhaps not quite as high as that of the PW8.

The Curtiss racer was a single bay biplane with "I" struts and a wing radiator. It had a new type of Reed propeller made from a duralumin forging instead of from a flat plate. It also had the new Curtiss V 1400 motor with 6:1 compression ratio and developing 619 hp. The engine mount was of welded steel tube and the fuselage was of wooden monocoque construction. It had a speed of about 250 mph.

The new Fokker F8, trimotor transport was also seen. It was fitted with three Wright J4 engines. It carried eight passengers, two pilots, 300 lb. of baggage and had five hours fuel at a speed of 125 mph. It had a plywood wing and a welded steel tube fuselage.

Schneider Cup Entrants

At about this time I also saw the Schneider Cup Seaplane Race at Baltimore. The winning machine was developed from the Army Curtiss Racer. It was fitted with the new Curtiss V 1400 engine and had wooden floats. Flown by Doolittle, it achieved an average speed of 232.5 mph.

The beautiful Supermarine R3C-2 monoplane had a veneer covered wing and was fitted with a Napier engine, but it crashed, apparently as the result of a stall on a turn.

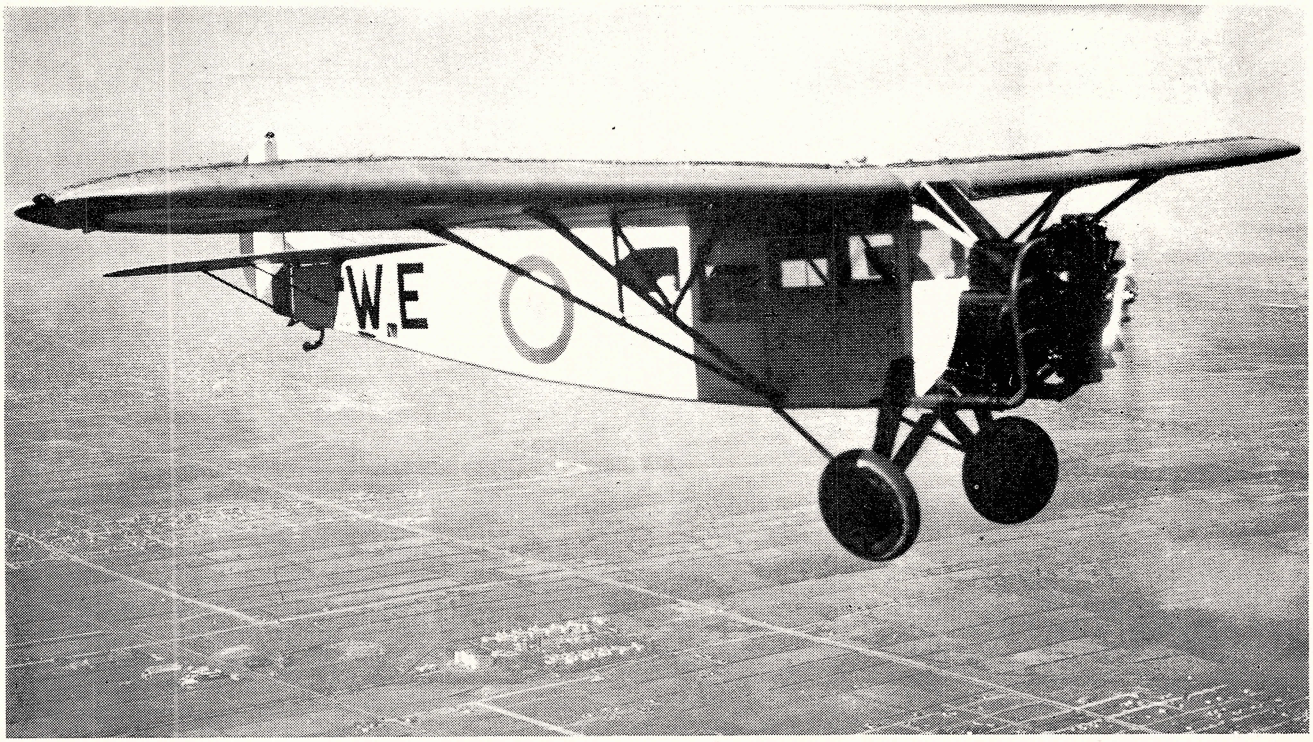
The Gloster entry was a biplane with a Napier engine and duralumin floats. It came in second at an average speed of 199 mph.

Two other machines, the Navy Curtiss racers, were withdrawn from the race due to engine trouble.

Delivery of the Lynx engined Vedettes commenced in the late summer of 1926. In November of that year Tom Cowley (Air Vice Marshal A. T. N. Cowley CBE retired) while flying up to Petawawa to bring J. A. Wilson and I home to Ottawa experienced a loss of engine power, due to carburetor icing.

This trouble, under apparently good weather conditions, had been causing us some concern. We started to design heat exchangers which would collect heat from the cylinder barrels and carry it to the carburetor.

In the Vedette and the Varuna, the engines were fully exposed to the air stream and there is no doubt that this lucky diagnosis quite early in the period of flying over the north country saved some forced landings or crashes which might have remained unexplained. The heat from the rest of the engine soon melts the ice in the carburetor and the evidence as to the cause of engine failure disappears.



NORTHERN WORKHORSE. The first Pratt and Whitney Wasp-engined version of the Fairchild FC2, which was produced at the request of the Technical Department of the Air Board, and was the forerunner of a line of Northern "workhorse" aircraft.

From Boxkite to Jet

Experiments and Adaptations

By A/V/M E. W. Stedman

A device which promised to alleviate engine starting difficulties was an inertia starter developed by the Eclipse Machine Company, and this was quickly adopted in Canada.

A small flywheel was speeded up through gearing by hand-turning, or by an electric motor, and then engaged with the engine thus using the energy stored in the high speed flywheel to turn the engine.

The Eclipse Inertia Starter filled a long felt need, particularly for cold starts. It was soon universally adopted.

Interest in winter flying was spreading. In the winter of 1926 the Air Ministry sent over two Armstrong Whitworth Siskin fighter aircraft for winter tests at Edmonton.

Skis for these aircraft were designed in my department during the fall of 1925, the drawings being made by Charlie Cotton (Group Captain C. H. Cotton).

The Siskin and the two-seater army co-operation Atlas were of steel strip construction. Both machines were fitted with the Armstrong Siddeley "Jaguar" engine.

The steel strip method of construction, developed in England, was based on the ingenious use of thin strips of high tensile steel. The strips were always curved in cross section to avoid secondary buckling and were made to slide one into the other to form box-spars and other sections. The whole method was, in effect the replacement of wooden members such as spars, ribs, struts, longerons, etc., by similar members made from steel strip.

Metal construction was developing in the United States and at this time the first extruded duralumin sections were being used, experimentally by Morse, for wing spars. The U. S. navy used duralumin hulls for their flying boats, protecting them with varnish, bitumastic paint or just plain grease.

In May 1926 I saw the Ford Trimotor monoplane under construction, though it was not until 1928 that it went into production.

The machine had three Wright J 5 air-cooled engines. It carried twelve passengers or a useful load of 2,500 lb. with a pilot and six hours fuel. It was of duralumin construction with metal-covered wings and had a loaded weight of 9,200 lb. Anodic coating had been used on some of the skin and some experiments had been made with "Alclad" duralumin.

In the winter of 1926-27 the First Pursuit Group of the USAAF requested permission to visit Ottawa in mid-winter to test out their winter flying technique. The group, comprising about twelve Curtiss P1 fighters and a Douglas machine carrying mechanics and supplies, arrived in very cold weather with bright sunshine and landed on the Ottawa River opposite Ketchum's boat house.

The aircraft were fitted with metal skis with canvas fairing but the fighters had no tail skis. As each fighter landed and the speed dropped to the point where the tail skid touched the ground, the tail skid broke through the crust on the snow and the rudder was damaged.

Clive Hume immediately got busy at No. 1 Depot making metal spoons to attach to the tail skids. This gave more surface and helped prevent them from breaking through the snow surface.

On the morning that the group was due to leave several of us went to the Chateau Laurier in the morning to see if we could be of any help in getting the machines started. We were told that they wanted to get away using their own resources if possible.

The crews did not go down to their machines until just before take-off time, assuming that there would be no difficulty. But their usual method of starting proved of no avail. In the meantime we had arranged for the city hydrant thawing-out equipment, consisting of a steam boiler mounted on a sleigh, to be available. Finally, after more than an hour's delay, we were asked to give assistance and by the use of heat and doping with ether the engines were soon started.

I think the group learned a great deal from this visit, which was made in very cold weather. Their initiative in making the visit deserves considerable credit.

During 1927 we were experimenting with a very small single-seater flying boat for forest patrol, based upon experience at the British Light Aeroplane Trials. The aircraft was designed and constructed by Canadian Vickers to the Department's specification and had the distinction of having the first metal hull designed and built in Canada. Known as the Vista, it was powered by an Armstrong Siddeley "Genet" engine of 60 hp.

The Vista project demonstrated that it was possible to build a flying boat of this small size, but it also taught us that such an aircraft could only be used in very sheltered water.

At the Light Aeroplane Trials aircraft using engines of 30 hp or less had been demonstrated. I have no doubt that many people felt they had too little reserve for serious work and that an engine of about 60 hp would be better.

Moth's Canadian Debut

The de Havilland Company apparently had such ideas because besides building the small DH-53 they also constructed a two-seater airplane using the Cirrus engine of about 60 hp. This machine was demonstrated at Lymphe and later became famous as the Moth. It was introduced into Canada for forest patrol, filling the need for an inexpensive airplane for this and similar duties.

Early in 1927 F.E.N. St. Barbe of the English de Havilland Company came to Canada and sold the Ontario Provincial Air Service a number of Moth airplanes fitted with the Cirrus II engines. At about the same time the RCAF bought at least one of these aircraft, because I recall that a Moth seaplane was sent with the Hudson Strait Expedition in 1927.

In 1927 Canadian Vickers produced a totally enclosed bi-plane fitted with floats and an air-cooled Wright engine. This machine, the Vanessa, was one of the first revivals of the totally enclosed machines. It was a very bold step forward in design, and its performance was very good, reflecting great credit on the designer, W. T. Reid.

When still in the experimental stage it was used for a flight to pick up mail at Rimouski and carry it to Montreal. In the course of this operation the machine was wrecked in heavy seas and became a total loss.

About the same time this company built to the Department's specification a photographic aircraft, named the Velos. Its eventual failure was undoubtedly due to the fact that there were too many people concerned with the design requirements.

The Fairchild FC2 came into use for photographic work in Canada in 1927. It was a folding monoplane using a Wright Whirlwind engine of 200 hp. Its span was 44 feet. It had a speed of 112 mph with a ceiling of 13,000 feet.

The FC2 had a triangular shaped fuselage with one longeron at the top. As a consequence was known as the "razor back" Fairchild. The fuselage was of welded steel tube and the wings were of wood with a fabric cover. The floats were built from a wooden frame covered with duralumin sheet. The earliest record that I have of the Fairchild FC2 is a design for winter landing gear dated October 1927.

Interesting developments had been taking place in the air-cooled engine field. A group of enthusiasts, Renschler, Mead, Willgoos and Brown, after linking up with the Pratt & Whitney Company of Hartford, had produced an air-cooled radial engine of rather more than 400 hp known as the Wasp engine. This development was encouraged by the U. S. Navy Department under Admiral Moffett with Commander Eugene E. Wilson as head of the engine section. There was also interest by Chance Vought.

We kept in touch with this development from the start. After the first flight was made in May 1926, the engine was put into production by 1927. We were soon convinced that this engine was of value to us.

We asked the Fairchild Company to produce for our Department a machine similar to the FC2 but fitted with a Wasp engine. This machine was called the FC2W and had a square section fuselage. It was used a great deal for photography and similar work during the next few years.

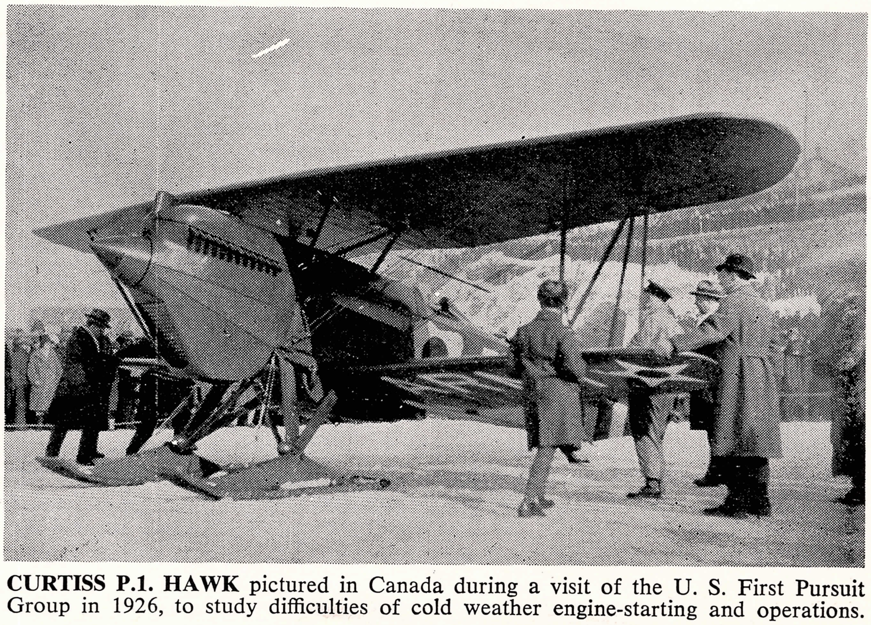
Alan Ferrier speaks of the first Fairchild FC2W in his unpublished memoirs:—

"It was Canada that ordered the first Wasp Fairchild, the forerunner of the FC2W and its descendents. The jump to nearly 400 hp was a real adventure in those days. I was told that the Fairchild Company had to get a release from the U. S. Navy in order to get the engine for the prototype. I went to Amityville, L.I., with Roy Grandy (Group Captain R. S. Grandy OBE, retired) and Frank Wait (Air Vice Marshal F. Wait CBE, CD, retired) to do the first trials.

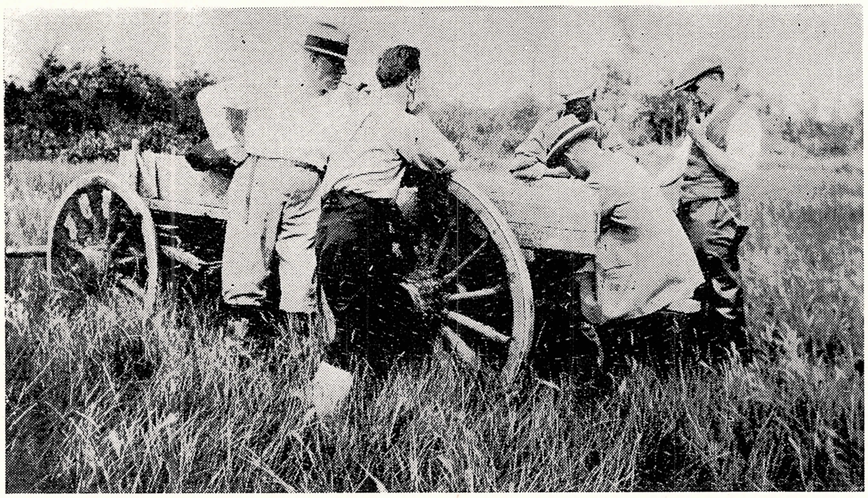
"The prototype, now with four longerons, was so successful that Canada ordered a batch of production FC2W (the W meant Wasp) to be built in Canada, which was the motivation for the Fairchild Aircraft Company at Longeuil."

Also, Art James writing about the Fairchild line of machines thinks that they should be given some prominence because the Fairchild 71 became known as "the workhorse of the North." He writes: —

"The FC2W was further developed for the U. S. Army Air Corps and became known as the '71.' It was the RCAF, however, which adopted the '71' for aerial photography."



CURTISS P.1. HAWK pictured in Canada during a visit of the U. S. First Pursuit Group in 1926, to study difficulties of cold weather engine-starting and operations.



CRASH ENQUIRY, 1927 style, to investigate the crash of a Vickers Viking flying boat. An indian witness (facing camera) is interviewed by members of enquiry team.

From Boxkite to Jet

Crashes and Salvage

By A/V/M E. W. Stedman

In the summer of 1927 there was an accident to a photographic Viking that caused us some concern. It appeared the structure of the aircraft had failed in the air, and an essential part of the work of the Aeronautical Engineering Division was to ensure that the aircraft in use were as safe as existing knowledge permitted.

A court of enquiry, consisting of Colonel Stevenson, chief forester for Manitoba, Colonel R. H. Mulock, George Walsh (Air Vice Marshal G. W. Walsh CB, CBE, retired) and myself, was sent to the scene of the accident, near Lake Winnipegosis, to carry out an investigation.

The wreck indicated that the nose of the hull of the boat had probably broken off downward while in the air. The best evidence was obtained from a young Indian who was working nearby at the time of the accident. From his evidence it was concluded that the aircraft flew into a large cumulus cloud and emerged at low altitude with the nose down and at high speed, necessitating a sharp pull out. It was during this pull that the failure occurred.

At that time almost any machine could be broken in the air by being pulled out too quickly from a high speed dive. But this incident raised the question as to why the hull failed before the wings. The stresses that occur in a body such as a hull are not easily estimated, especially those that occur in the vicinity of an opening such as a cockpit. In such cases, if there is any reason to suspect excessive stress, the safest thing is to conduct a test to destruction to find out if and why the calculations are incorrect.

We obtained permission from headquarters to test another Viking hull to destruction. At Lac du Bonnet we rigged up the fuselage and loaded it with sand-bags to simulate the weight of the crew and equipment.

The load was gradually increased until failure occurred at a figure somewhat lower than was desirable. It was similar to the type of failure that had occurred in the air. The hulls of all Vikings were afterwards fitted with an extra mahogany plank on the outside of each side of the hull at the level of the top longerons, and no further difficulty was experienced.

In 1927 the Department was asked to provide an air patrol for a Hudson Strait Expedition, under the direction of the Department of Marine. The object was to study ice conditions through the Strait during one whole winter. For this purpose we chose six Fokker monoplanes and one de Havilland Moth seaplane. The Fokkers were fitted with floats, wheels or skis and gave good service, but the open cockpit was a great drawback.

Salvage Operations

In November of 1927, I learned a useful lesson in salvage. Previously, I had gained a good deal of experience in the salvage of aeroplanes that had been damaged on land. It had been demonstrated that if proper precautions were taken the work of repair could be simplified whereas careless salvage could result in total loss.

There seemed to be special factors to be considered when salvaging seaplanes. Many seaplanes had been only slightly damaged in a crash, but had, for various reasons, become a total loss by the time they were received at the repair depot.

On this particular occasion a Fairchild FC2 had been turned on to its back, in shallow water at Shirley's Bay near Ottawa. When I arrived, there was a perfectly good seaplane lying on its back in about six feet of water with its floats sticking up in the air clear of the water. It was immediately in front of the Air Station with all the boats, tools and experienced mechanics necessary for salvage.

The salvage operation proceeded rapidly and with every precaution under good but cold weather conditions. The floats were removed undamaged, then the fuselage was raised and towed to within a few feet of the shore. In very shallow water, where the wings were just awash, they were disconnected from the fuselage and floated ashore. The aircraft appeared undamaged except for water soakage. The fuselage was also brought ashore apparently undamaged, as were the engine and propeller.

The wings were taken to the repair depot and stripped for examination. This showed that the hollow wooden spars were filled with water that could not be removed without serious damage to the glued joints. The fuselage tubes had also filled with water which had subsequently frozen and split certain of the tubes.

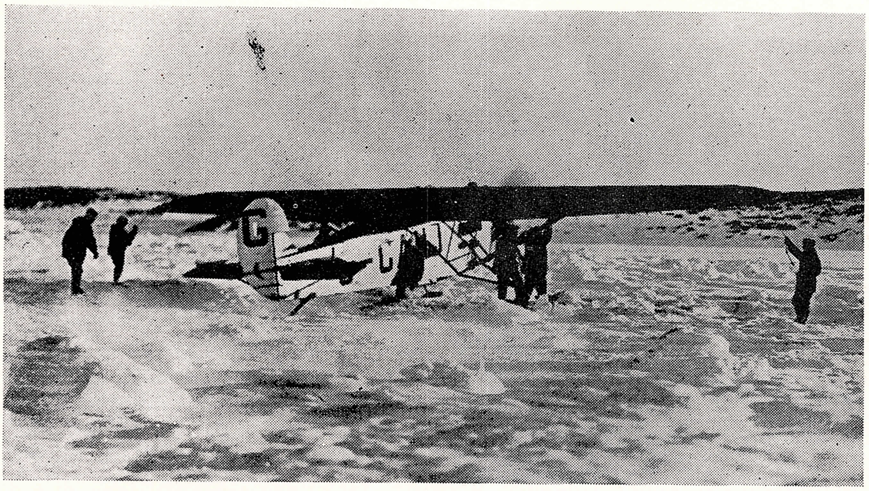
This, and other similar instances, led to the requirements that in welded tube fuselages each tube must be provided with drain holes, with some thought given to the method of getting rid of water from inside the tubes.

The engine and propeller were satisfactory after stripping and cleaning.

After this experience, which showed that with all facilities available there was still a considerable loss, I had a better understanding of the difficulties liable to occur during the salvage of aircraft that had been submerged in water.

Commenting on this story of salvaging the overturned Fairchild FC2, Tom Cowley writes:

"I was the pilot in the upsetting incident . . . The contributing cause however was of great interest . . . The real reason in my opinion was not the wind which, while strong and gusty, was obvious for any experienced pilot to judge and counter, but the fact that a/c imported from the U. S. did not have 100 percent excess buoyancy. I can still see the leeway float getting deeper and deeper in the water as I turned into wind for my take off run!



FOKKER UNIVERSAL, fitted with skis, served as part of the air patrol for a Hudson Strait Expedition, 1927. Six Fokkers and one de Havilland Moth took part.

I believe that at your insistance we raised the excess buoyancy requirement to 100 percent and also increased the distance between the floats."

This question of the amount of excess buoyancy necessary for safety was just another of the many things that had to be determined by experience.

More Funds Voted

During the years 1927 to 1931 the amount of money voted annually for aviation gradually increased to nearly $7,500,000 in 1930-31. Of this nearly $5,000,000 was for Civil Government Air Operations. In 1927 the operations for other government departments had increased and as a consequence it was necessary to reorganize the department. The RCAF continued as a Directorate responsible to the Chief of the General Staff, and three new branches were created to administer the Civil Government Air Operations, Civil Aviation and Aeronautical Engineering. These latter three branches reported to the Deputy Minister.

In 1928 we prepared a specification for a flying boat with a metal hull to undertake the work previously done by the wooden hulled Varuna. Canadian Vickers were given the contract for this boat known as the Vancouver. About the same time we asked for a metal hull for the Vedette.

In the summer of 1928 I visited practically all the aircraft and aero-engine manufacturers in England. France and Germany. In England one subject of enquiry was the slotted wing produced by Handley Page. I had been associated with the firm during the early experimental work on this device which had by now come into general use.

Pat Cuffe flew me from one factory to another in a slotted de Havilland Moth. De Havilland had produced a metal fuselage for the Moth and were in the early stages of the development of the Puss Moth which had some features that interested us. There was also the Avian of A. V. Roe which attracted our attention.

The Gloster Aircraft Company's designers were busy on a Schneider Cup machine, but they felt that it interfered with their business because their best men were concentrating on the racer instead of a machine that might go into production.

The Bristol Aircraft Company were considering plans for representation in Canada.

Armstrong Siddeley had produced a set of floats and a seaplane undercarriage for the Atlas aircraft for Canada, but the floats had not yet been tested. It was felt that they did not appreciate our problem of changing from wheels to floats each year because the fuselage of the plane had to be modified to take the seaplane undercarriage and the land chassis could not be fitted until the fuselage had been converted back to its original condition.

A number of good flying boats were examined, such as Short's Calcutta and Singapore II and the Supermarine Southampton. But they were all too large (or perhaps more accurately too expensive) for our purpose. A visit was made to Felixstone to get opinions on the flying boats and also to discuss seaplane testing.

Airship Construction

The airship question was very much to the fore at this time and I visited Cardington to see the R-101. The central framing and one gas bag were erected and one engine nacelle had also been assembled for testing. At the Airship Guarantee Company at Howden in Yorkshire the structure of the airship R-100 was erected in skeleton. The main members were spiral duralumin tubes about three inches in diameter, made by rolling a duralumin strip in a spiral.

The general trend in aeroplane construction seemed to be to give up the steel strip type of construction and to use duralumin with fabric covers. But there were some experimental metal covered wings. Vickers were working on the Wibault method, and on the Beardmore Inflexible, an all metal monoplane, built under license from Rohrbach.

I attended the Paris Aero Show in July, 1928. One of the things that drew my attention was work being done by Wibault that I had already discussed with Vickers in England. Perhaps it was his idea which attracted me more than the things he had actually produced.

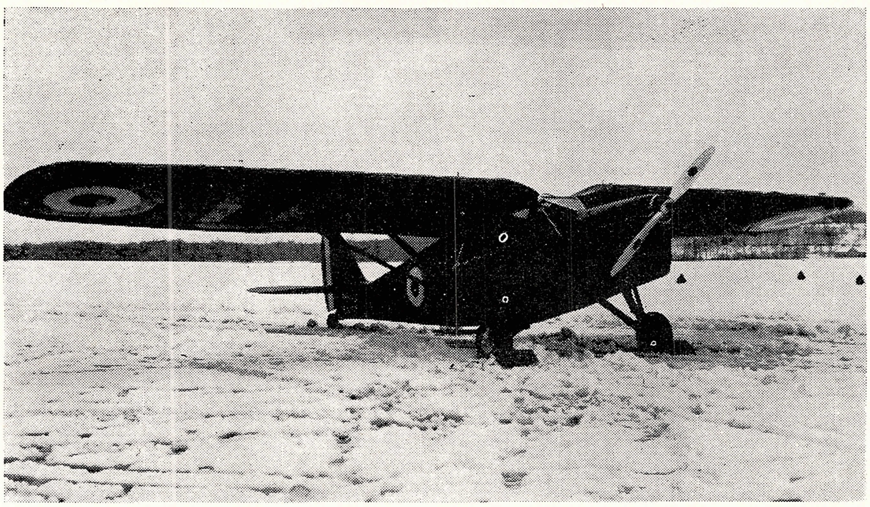
He felt aircraft designers should agree on certain standard sections for drawn or extruded duralumin and use these sections in their design work in the same way that structural engineers used standard rolled steel sections for steel construction. His factory had very few machine tools. The airplanes he produced were limited to square section fuselages and square shaped wings. The interesting thing was that performance of his aircraft compared well with that of airplanes produced by more complicated methods.

We are always on the lookout for methods of starting aero engines and at this time the Farman Starter was new and looked good. It consisted of a small gun in which a special cartridge was fired and the gases led to one engine cylinder, the piston of which had been placed just beyond top dead centre. We acquired some of these starters and used them for some time, but they fell into disuse as the inertia starter became more generally available.

In Germany the most interesting features were in the all-metal construction used by Junkers and others. Pat Cuffe and I flew in some of these aircraft. At Dessau we saw the Junkers W33, which was like the "Bremen" that had flown from Ireland to Canada in April 1928, the first airplane to cross the Atlantic from East to West. It had possibilities as a photographic aircraft.

We also saw the Junkers G24, a three-engined all metal, low wing monoplane with three Junkers L5 engines. It carried two pilots, wireless operator and nine passengers. A similar machine the Junkers G31, had three "Jupiter" air-cooled engines.

Most of the aircraft in use in Canada at this time were biplanes or high wing monoplanes. I remember the pleasure I experienced when flying for the first time in a low wing all-metal monoplane.



EARLY ARRIVAL. First de Havilland Puss Moth received in Canada—in 1931. This type suffered early troubles, but after modification, remained in service until 1936.

From Boxkite to Jet

Industry Takes Shape

By A/V/M E. W. Stedman

In December, 1928, an important International Conference on Civil Aviation was held in Washington. A large number of Canadians attended.

The delegation was headed by G. J. Desbarats, CMG, Deputy Minister of National Defense and included J. A. Wilson, Controller of Civil Aviation; Lindsay Gordon, Director of Civil Government Air Operations; F. H. Peters, Director of the Topographical Survey Branch; P. T. Coolican, Assistant Deputy Postmaster General, and myself.

The conference discussed many of the aviation problems of the time and brought about a better understanding between nations on questions of international air travel, which was beginning to become important.

A new propeller which had forged duralumin blades appeared in the United States during this period. This development was pioneered by the Standard Steel Propeller Company in collaboration with the USAAC. Hamilton Aero, another leading propeller manufacturer, soon followed suit and also marketed propellers with forged duralumin blades. These two companies were later merged by the United Aircraft and Transport Corporation to form the Hamilton Standard Propellor Corporation, in 1929.

I went to the works of the Aluminum Company at Cleveland to enquire into the method of manufacture of these forged duralumin propeller blades. It was interesting to see the blades forged almost to finished size under a hammer (work requiring the greatest skill on the part of the operator) and then finished with a die.

I also obtained information on the methods in use for the periodic inspection of the blades. As our department had to issue the Certificates of Airworthiness, we not only had to know the method of manufacture was sound, but also how to ensure that the propeller blades continued to be safe after long period of use.

Subsidiaries in Canada

By 1929, engine manufacturers were beginning to be interested in the Canadian market and were establishing shops for servicing their engines. Canadian Wright Limited was incorporated in 1927 and in 1929 Bristol Aircraft Engines of Canada Limited was formed. These companies operated as wholly owned subsidiary companies of Aero Engines of Canada Limited, a holding company, and handled engines built by the parent companies. Armstrong Siddeley were located with the Ottawa Car Company in Ottawa. Canadian Pratt & Whitney Co. Ltd., was incorporated on the 29th November, 1928. They had rented the original space used at Longeuil in October 1928 and fitted it out so that the company was ready to assemble and overhaul "Wasp" engines from January 1st 1929.

Aircraft manufacturers were also interested in the Canadian market. Canadian Vickers had of course been active for some years. In 1927 the Ottawa Car Company became agents for the Consolidated Aircraft Company and later they made arrangements with A. V. Roe for the Avian.

The de Havilland Aircraft of Canada Ltd., was formed in March 1928, and sold a number of Moths. These machines all had wooden fuselages. A year later, in March 1929, the company was reorganized as a Canadian Company and sold a large number of Moths with Cirrus II, Cirrus III and Gipsy I engines, all with plywood fuselages.

Many of these aircraft were purchased by the RCAF, the newly formed flying clubs, individuals and operators and a further batch by the Ontario Provincial Air Service. Late in 1929 the first Moth with a steel tube fuselage was received.

W. T. Reid, who had been designer for Canadian Vickers, started his own company as the Reid Aircraft Company in Montreal. It later became the Curtiss-Reid Aircraft Company Ltd.

Fairchild Aircraft Limited, which had done a good deal of business in Canada, established a factory in Montreal, and the Boeing Company established a connection with the Hoffar Shipyards in Vancouver.

In 1928 Dr. Tory resigned as President of the University of Alberta to become president of the National Research Council with headquarters in Ottawa.

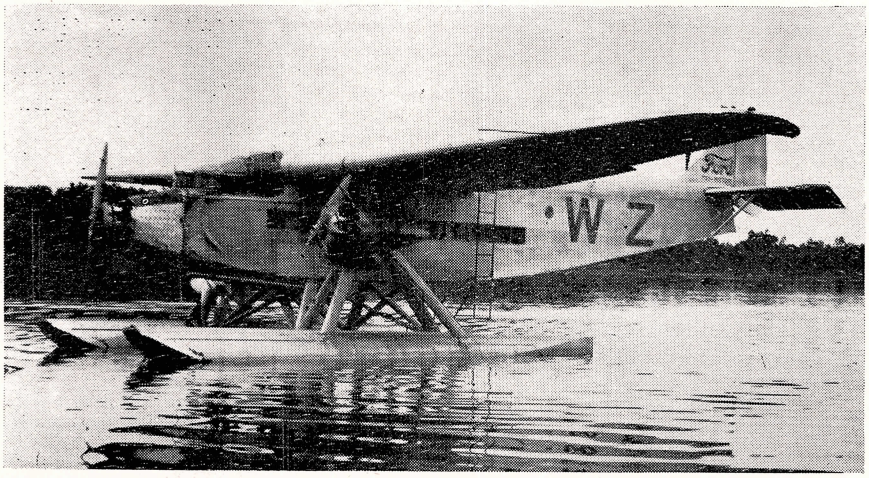
Research Facilities Grow

In the air estimates of the Department of National Defense for the following year there was a sum for the construction of a water channel for testing seaplane floats. The question arose whether we should start a laboratory of our own similar to those in other government departments, something we were hesitant to do; or whether it would not be advantageous to all concerned if we threw in our lot with the National Research Council. In any event it was essential that more research and test facilities be made available, and the latter course was adopted.

Dr. John Parkin, of the University of Toronto, was appointed in July, 1929, to head the aeronautics branch, which was then a part of the Physics Division. He was made head of the Department of Mechanical Engineering in 1936.

Some of the work undertaken by N.R.C. for the RCAF can be gathered in the following extracts from a letter from Dr. Parkin. He writes:

"The first laboratories organized were the model testing basin, at your request, and the wind-tunnel which Dr. Tory, I believe, had undertaken



TRIMOTOR CONVERSION. This Ford Trimotor, purchased by the Air Branch, was fitted with floats and skis for Canadian operations, which included forest dusting.

to provide; the engine laboratory to enable Canada to fulfill its international obligations covering the certification of aircraft built or assembled in Canada, and the fuel testing laboratory. Later in 1932, when the old Department of the Interior was wiped out by the Bennett Government, the Physical Testing Laboratory of that Department was absorbed by the Council and the setting up of an aircraft and allied instrument laboratory was authorized by the president in June 1932 using the equipment of the PTL.

"The gasoline testing equipment (knock rating) was operating as early as October 1930.

"The wind tunnel was first run 28 May 1931 but it was some time later that a balance was available. The first test in the Basin was made pulling the car by hand in August 1931 and the first power run of the tank car was in October of that year.

"The Heenan Frood engine dynamometer was first run in December 1931 using the Rolls IX engine, and the test of the engine to the Air Ministry procedure was made.

"Some of the projects undertaken for the D.N.D. were . . .

"An investigation of the strength of thin flat plates under pressure, as in float and hull construction, was requested early in 1931 and this investigation was worked on often during succeeding years. At a conference which you and Ferrier attended on 21st February the project difficulties were reviewed and it was decided to use a different setup in which the test specimen was to be the central rectangle in a set of nine.

Test Procedures

In this same letter Dr. Parkin speaks of requests for tests of three sets of floats for the Bellanca Pacemaker; tests on the pitching moment of skis in flight, which led to the development of the streamlined zero pitching moment NRC ski about which more details will be related in its correct sequence; an official type test of the Wright J6 engine; tests to determine the loss of power after 200 hours operation in an engine operating on oil lighter than that specified by the maker.

Other items of interest in Dr. Parkin's letter are: "On 16 March 1932, the President approved the suggestion of Group Captain Stedman that the upper floor of the engine test building should be used as a museum for aircraft engines. At that time a number of obsolete engines were in storage."

After some years it was evident that the Edwards Mill site must be vacated and the National Research Council provided new buildings and equipment at the present Montreal Road site, where facilities for aeronautical research and testing have kept pace with a growing demand. These facilities have proved a great asset to the whole aircraft industry in Canada and are such that we may be justifiably proud of them.

During the last months of 1929, and the early thirties, we took on a number of new types of aircraft.

In 1929 we purchased a Ford Trimotor monoplane and fitted it with floats and skis. The skis were particularly interesting because this was long before the days of cleared runways. With the low snow loading considered necessary to take-off from soft snow, these skis were very large.

On the first flight, with Roy Grandy as pilot, I remember looking down at the skis and thinking that they resembled barn doors. They proved effective but I do not recollect that they were used very often. This Ford Trimotor was used, among other things, for forest dusting using a hopper and distributing system that was designed in the department in April 1930.

The metal hulled Vancouver ordered some time before, was delivered by Canadian Vickers in 1929 and found to be very satisfactory. Also during this year we obtained two other types, the Avro Avian and the Curtiss-Reid Rambler. The latter machine, the first product of the new Curtiss-Reid Company, was an all-metal framed, fabric covered two-seater training machine. It had a Warren type truss with rigid struts and no wire bracing.

Famed Siskin Flight

At about this time we also purchased some Armstrong Whitworth Siskin fighters. I have no record of the actual date of purchase, but there are records of the famous Siskin flight, which gave many exhibitions throughout Canada, in 1930 and in 1931. Prior to this, since 1926, some Siskins, supplied by the Air Ministry, had been in Canada for winter flying tests.

In 1931 we purchased the Fleet Trainer and the Bellanca Pacemaker. Every new type of aeroplane introduced from Britain or the United States required considerable conversion to make it suitable for floats and/or for winter flying. The department was constantly designing, or re-stressing parts designed by others, for conversion of these new types. It was in this same year, 1929, that we received our first Puss Moth.

During the thirties the advance in aviation in Canada was slow due to the depression. Air estimates of the department were drastically cut. In an endeavour to retain as many trained personnel as possible the purchase of new aircraft was avoided.

At this time a great change was taking place in the methods of construction of aircraft: from wood or metal frames covered with fabric, to the all-metal monoplane.

In the fall of 1931, at a time when there was no money available for the purchase of new equipment, I obtained permission to attend McGill University to take a course in Metallurgical Engineering. I felt this would make me better fitted to deal with new developments in methods of construction and enable me to obtain a better understanding of the metallurgical problems involved in the manufacture of aero-engines.

In January and February 1932 an Airworthiness Conference was held in England. Canada was represented by Lindsay Gordon, who was then stationed in Britain, and by Oliver Adams, who was sent over to England for the purpose. This conference resulted in several important changes in the official Handbook of Strength Calculations. After the conference the Air Council made a special commendation on the contribution made by the Canadian representatives.

The following account of an incident that occurred about this time, written in a letter to me by Art James, is of interest. He writes:

"I attended the Imperial College 1929-30 and afterwards spent three months on flight testing at Farnborough, Martlesham Heath and Felixstowe. Returned to your Division to take charge of flight testing which at that time, included both civil and military aircraft. The first test flight was organized under Flying Officer W. D. Van Vliet in the summer of 1930.

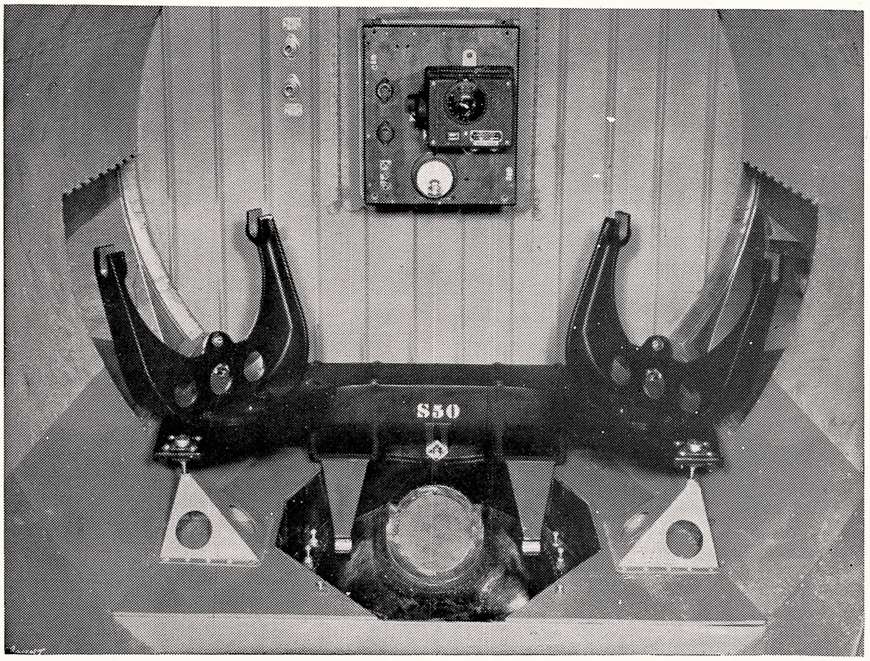
"Early in 1932 the reduced budget forecast for the fiscal year 1932-33 necessitated the completion of as many programs and projects as was possible before March 31, 1932. As I recall, I helped with outstanding flight tests at Camp Borden and Trenton. In March at Rockcliffe I was doing the stability trials of a Puss Moth fitted with leading edge slots with Sergeant Anderson (pilot) acting as my observer and learning the technique of test flying. We had completed some six hours or so of this test by the morning of March 21, 1932. As I remember it was a clear cloudless day, almost perfect for test work.

"We had been airborne for over an hour and had completed a number of timed recovery from stalled positions when, with no warning other than a sudden shudder, a wing failed.

Neither of us, although wearing parachutes, was able to leave the aircraft before coming down out of control. This was one of some five or six unexplained Puss Moth accidents. A thorough enquiry by U. K. Airworthiness authorities determined that the failure was due to 'Flutter.'

"As I remember, after all Puss Moth wings had been modified the aircraft were placed back in service and were used until 1935 or 1936. I flew one once again from Camp Borden to Montreal either late in 1933 or the spring of 1934 to meet Air Commodore J. L. Gordon with whom I flew back to Toronto."

This personal account does not state that he (Art James) was the only person to survive one of these Puss Moth accidents nor does it say that he was seriously injured in this accident and Sergeant Anderson was killed.



MULTI-CAMERA MOUNT developed by the Test and Development Flight for installing three cameras in the Northrop Delta and Fairchild Super 71 aircraft.

From Boxkite to Jet

Experiences Abroad

In 1932 as a result of the reduced amount of money available there was a re-organization of the Air Services. The strength of the RCAF on 31st March 1931 was 906 officers and men. By 31st March 1932 this figure was reduced slightly to 878, but at the same date the following year it had reached the low point of 694 officers and men.

The RCAF and the Civil Government Air Operations Directorates were consolidated and with the Aeronautical Engineering Division were placed under a Senior Air Officer responsible to the Chief of the General Staff. The fourth branch of the government air services, the Controller of Civil Aviation, remained under the Deputy Minister. Although now under the SAO the Aeronautical Engineering Division retained certain responsibilities with respect to civil aviation, particularly airworthiness certification.

In 1933-34 the vote was even less: $1,600,000. But this was gradually increased through 1934-35 and 1935-36 to a total for the RCAF and the CGAO of $4,306,000.

During 1933 over half the flying operations were carried out by the Ottawa Air Station where the Test and Development Flight worked with the Aeronautical Engineering Division and the National Research Council in the test and development of aircraft and equipment. Records show that this was a period of great activity in the design of mounts for carrying more than one camera, allowing photographs to be taken simultaneously from two or three cameras and thus cutting the flying time and aiding the plotting of the photographs.

The first of these mounts was made in the winter of 1932 as a double camera mount for the Bellanca. This involved fuselage and floor modification. In March 1933 this was followed by what was called a multi-camera mount, using three cameras. There were new versions in 1934 and 1935.

The latest of these was installed in the Northrup Delta and the Fairchild Super 71 in 1937. It consisted of a magnesium casting tying the three cameras.

I also have a note of the installation of a Barr and Stroud seven-lens camera in a Bellanca in November 1935 but I have no recollection of the amount this camera was used.

Writing to me about the tri-camera mount recently Alan Ferrier said: "The latest development was a mount for three cameras, all solidly held by the mount and calibrated as a system in the laboratory, the entire assembly being subsequently mounted on a system of shock absorbers in the Delta and the Fairchild Super 71."

Trials were also made with an automatic pilot as an aid to photography. This work was carried out by Alan Ferrier and Van Vliet, who was in charge of the test flight. On my visit to Farnborough in the following year, officials there expressed great satisfaction with the work done with the RAE Automatic Pilot. Our success with this instrument evidently exceeded their expectations.

In 1934 I visited practically all the manufacturers of aircraft, engines, and instruments in Britain; also various RAF establishments, Woolwich Arsenal and the steel manufacturers.

One of these visits was to Cardington to inspect some Atlas aircraft in storage there. A proposal had been made that we should acquire some of these aircraft, have them reconditioned and then use them in the RCAF. A number were judged suitable for reconditioning and later came into use in Canada.

At the Supermarine factory we saw an experimental all-metal monoplane fighter based on experience gained from building the Schneider Cup racers. It was made from Alclad duralumin and had a wing span of 46 feet.

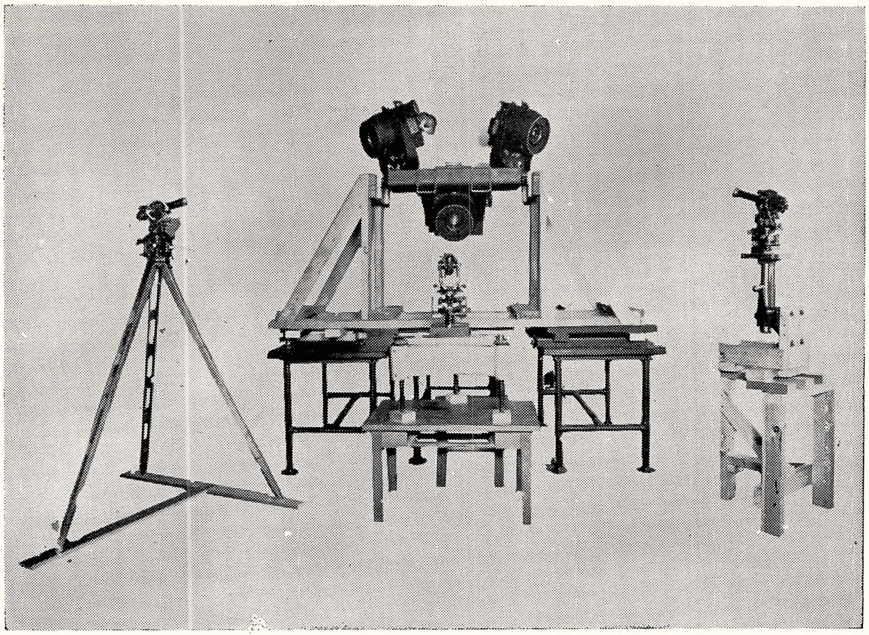
At the Gloster factory we saw the Gauntlet in production. It was a tractor biplane, with two sets of struts on each side. Fitted with a 600-hp Bristol "Mercury" engine, it had a top speed of 228 mph at 15,800 ft. The construction was mainly steel-strip with duralumin ribs.

In many of the factories the anodic treatment for the protection of duralumin was still being used long after the more practical Alclad was adopted by our manufacturers.

Metal Covering Snags

Metal covered wings were disliked because of their weight per square foot. No satisfactory device for allowing an increase in wing loading was available. Slots were used but trailing-edge flaps were not in general use. Metal monocoque fuselages were also not liked because they did not allow the accessibility to instruments etc., that was considered necessary by the Air Ministry.

A new form of construction had been conceived by B. N. Wallis of Vickers, designer of the Airship R-100. It was called Geodetic construction and consisted essentially of a triangulated structure forming the desired shape for the wing or fuselage, which was then fabric-covered. It was light, when compared with metal-covered structures which were then being advocated. It is interesting that from time to time various people claim to have discovered, or invented, a new form of structure for building which is



CALIBRATION of the multi-camera mount was facilitated by this laboratory rig.

simply a rehash of Wallis' geodetic method.

Metal airscrews were not favored in Britain at this time. The only successful type, made by Fairey, was considered too expensive when compared with a wooden airscrew. The Hele-Shaw variable pitch airscrew was not advancing very rapidly. De Havilland had taken a license for the manufacture of Hamilton - Standard variable pitch propellers.

Through the kindness of Colonel Outram, director of Aeronautical Inspection, I spent some time in Sheffield studying the manufacture and inspection of steel parts for aero engines. I was able to follow through the manufacturing processes on rough forgings and semifinished parts as delivered to the engine manufacturers.

I also visited all the chief aero-engine manufacturers, following up the handling of steel forgings and the method of keeping check on batches of parts made from one shipment of forgings from the steel-makers.

On my return to Canada I visited Canadian steel manufacturers to see how their facilities for the manufacture of aero-engine parts compared with those at Sheffield. I decided that when the time was ripe, the industry, with its electric furnaces, could easily turn to the production of the special steels needed for aero-engines.

The question was, how should we proceed to establish an engine industry in Canada? It was obvious that this could not be a commercial venture because the market was not large enough to allow any Canadian-built engine to compete with an imported engine.

Nevertheless the idea persisted that in the event of war we would be unable to obtain engines from any outside source. We felt we should at least establish the art of building an aero engine, even at considerable expense, so that in time of emergency we could turn to the manufacture of any design required.

A proposal was put forward that we should establish at Victoria Island, in Ottawa, an aero-engine shop for this purpose. This shop would, in the first instance, import forgings, semi-finished parts, accessories, etc., so that all operations could be started at once. At the same time forgings, etc., would be purchased experimentally from local manufacturers. When found to be satisfactory these locally made parts would replace the imported parts.

Plans For Production

The intention was that this should be a pilot plant, laid out with a single line of machines for each item and not intended for production on a large scale. In the event of war the personnel employed would be available for use as foremen, instructors in industry or as inspectors. Given time we would thus learn the art.

This proposal was eliminated when the departmental estimates were being prepared. There were too many other things that had to be provided from the small sums available for defense purposes.

During the winter of 1933 we undertook winter tests, at the request of the Air Ministry, of the Hawker Audax army co-operation machine.

This work included the provision of skis. With the increasing performance of aircraft it became necessary to pay more attention to the aerodynamic design of the skis. Johnny Green (Dr. J. J. Green) writing to me about the wind tunnel work done by the NRC at this time says:

"The tests of full-size skis in the wind tunnel showed that, in general, the drag of a ski and its trimming gear was about three times the drag of a wheel. Thirty percent of this drag originated in the trimming gear. For high - performance aircraft the aerodynamic pitching moments to be controlled were so large and the trimming gear so stiff, in consequence, that there could be little if any flexibility when taxying over rough snow.

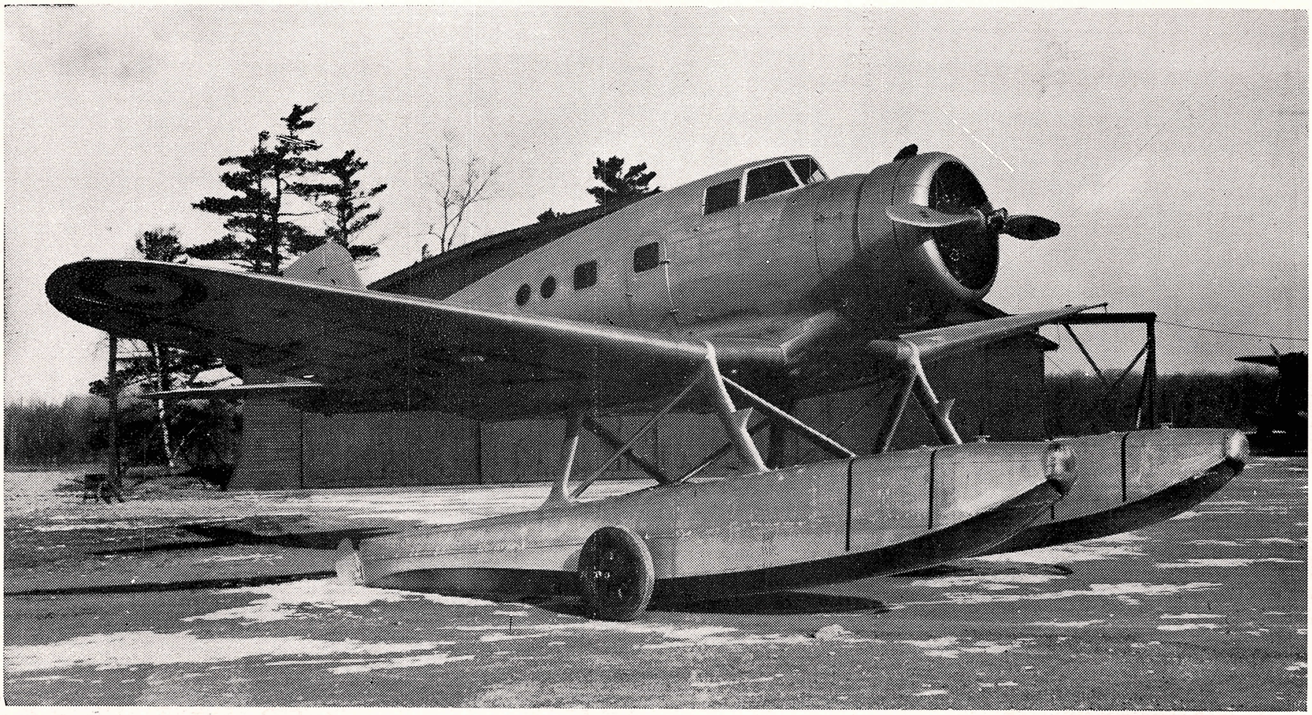
"The wind tunnel work was accordingly extended with the object of developing streamlined skis for which the air resistance and pitching moments would both be substantially reduced. If the pitching moment situation could be improved, some form of internal trimming gear might be adequate, thereby adding further drag savings by elimination of the trimming cables.

"The first work on this development was done in 1934 and 1935 and was aimed at the provision of streamlined skis for the Hawker Audax. The results were highly successful. Minimum drag was reduced by about 80% and pitching moments were cut to 50% or lower by streamlining the skis without in any way compromising the sliding performance on snow surfaces. A/V/M Ferrier designed a successful internal trimming and self-locking gear for incorporation in the new skis. Extensive flight trials on Audax and Atlas aircraft confirmed the superiority of streamlined skis over conventional skis in performance, handling and trimming."

The Civil Aviation Branch of the Department of National Defence had been considering types of aircraft for passenger-carrying at about this time. In September 1935 Tom Cowley and I were instructed to proceed to Chicago for the purpose of taking part in and reporting upon a demonstration flight from Chicago to St. Paul and return in a 10-passenger Lockheed Electra. Tom Cowley was to report on the flying side and I was to report on engineering matters.

Some years later, when talking to Bob Gross (Robert E. Gross, president, Lockheed Aircraft Corp.), he told me that at that time his company did not have a demonstrator Electra. In order to make the demonstration flight they had purchased all the seats on the return flight to St. Paul from Northwest Airlines, who were operating that type!

As a result of this flight a Lockheed 12 was purchased by the Civil Aviation Branch, which by that time had become part of the Department of Transport.



FIRST CANADIAN-built stressed skin construction aircraft was this Northrop Delta, produced shortly before World War II.

From Boxkite to Jet

Re-equipment Tempo Quickens

By A/V/M E. W. Stedman

The lean years of the depression found us dropping behind on current types of aircraft in operation. The result was that by 1935 we had requirements for many new machines.

In that year orders were placed for a number of different types, some to be manufactured in Canada. Most of the aircraft were not delivered until the following year. Among these were some Westland Wapitis, purchased from the Air Ministry and reconditioned.

One new type produced in Canada was the Northrup Delta, the first stressed skin aircraft built in this country. This involved a complete stressing job for airworthiness, which meant a good deal of study and investigation. Art James was brought into headquarters to lead a team on this work. Commenting on this job he writes:

> "In 1936 I spent six months on temporary duty at AFHQ heading a team composed of J. T. Dyment and C. W. Crossland to investigate structural analysis of stressed skin structures with particular reference to the Northrup Delta. This was a very interesting job and, I believe, contributed to the general knowledge of structural strength of this type of structure."

Charlie Crossland (Group Captain C. W. Crossland) also writes:

> "In July, 1936, I published a paper on High Altitude or Stratosphere Flying which set out the information I was able to collect. It visualized the use of a pressure cabin for carrying the passengers and crew and speculated upon the desirable cabin pressure. This paper was reprinted in the RAF Journal in England.

Growing Obsolescence

During 1936 by reason of our increased budget, we were able to order a number of new aircraft including some Stranraer flying boats and Northrup Deltas and Sharks. But the majority of our aircraft were either obsolete or rapidly becoming so.

On November 1st, 1936, the Department of Transport was formed. The office of the Controller of Civil Aviation Branch, which had been a division of the Department of National Defense, was transferred to the new department which also took over most of the civil government air duties previously performed by the RCAF, leaving the Force responsible only for aerial photography and some transportation work.

The Aeronautical Engineering Division of the Department of National Defence had until this time served the Civil Aviation Branch as well as the RCAF and as a consequence had been responsible for the airworthiness of civil as well as service aircraft. It now became necessary to split up our engineering staff to provide the nucleus for an Aeronautical Engineering Branch of the Department of Transport. Alan Ferrier was the obvious man to head up the new branch and he was seconded to the Department of Transport. He also selected from the engineers such men as were necessary to start the airworthiness section.

In 1937 there was a great increase in our appropriation to $6,809,215. This was influenced, no doubt, by the unsettled conditions in Europe. It permitted us to order a comparatively large number of aircraft, 104 in all.

Following the establishment of No. 2 Repair Depot at Winnipeg, No. 3 Repair Depot was opened at Vancouver. Technical Detachments No. 11 at Montreal and No. 12 at Toronto, were also formed under the command of RCAF engineer officers to account for and inspect work done in plants manufacturing aircraft for the Department. Previously we had resident inspectors at the chief aircraft plants, but with the placing of orders with a number of plants in one district it was desirable to have one officer in charge of the whole district.

Oliver Adams, who had temporarily replaced Alan Ferrier as my immediate assistant on the formation of the Department of Transport, was the first commanding officer of No. 11 Technical Detachment. He had to determine what was involved and he wrote the first order outlining the directions for other detachments. He also gave several weeks training to Bob Ford, who was to take over No. 12 Technical Detachment in Toronto when it was formed a little later. No. 13 Technical Detachment was formed in Vancouver in 1939.

Air Museum Begun

In 1937 the Air Research Committee made an attempt to save some items of historical interest in aviation. Space was provided in the main building of the National Research Council and a small aeronautical museum was started. We were lucky to obtain exhibits from Mrs. Gilbert Grosvenor, Mrs. David Fairchild, F. W. Baldwin, Hon. J. A. D. McCurdy, W. R. Turnbull and others. During the war the space was required for other purposes and the exhibits were moved to the Montreal Laboratories. Over the years they have been in the care of John Parkin, awaiting the establishment of the National Aeronautical Museum, and will now be exhibited at the museum at Uplands, Ottawa.

While in the RCAF, it was my policy to put aside for museum purposes samples of all engines used by the RCAF as they became obsolete and were replaced by other types. John Parkin has also preserved these engines.

By 1937 flying boat design had advanced to the stage where the direct crossing of the Atlantic seemed to offer commercial possibilities. In England Imperial Airways had the Short Caledonia and in the United States Pan-American Airways chose the Sikorsky Clipper III.

By agreement, the two airlines started experimental flights at the same time. Captain A. S. Wilkinson in the Caledonia left Foynes, Ireland, on the evening of July 5th, arrived at Botwood, Newfoundland, the next morning and at Montreal on the 8th July.

A party from RCAF Headquarters flew down to Montreal to see the arrival of this machine. It was particularly interesting to me, not only because it marked another step in conquering the Atlantic, but also because my old friend Herbert Brackley, who had been the pilot of the Handley Page entry for the Trans-Atlantic flight in 1919 and was now Air Superintendent of Imperial Airways, was personally responsible for organizing the flight. He had been present at Foynes to supervise the take-off arrangements.

Full Status for RCAF

Another re-organization of headquarters took place in 1938. The Senior Air Officer was made directly responsible to the Minister of National Defence and the RCAF was placed on an equal footing with the Navy and Army. Also, an Air Council was formed consisting of the Senior Air Officer (later Chief of the Air Staff), Air Staff Officer, Air Personnel Staff Officer, Chief Aeronautical Engineer and a Secretary.

It was at this point that the RCAF began to show some signs of growth. On March 31st, 1937, the total strength of the RCAF Permanent Force was 1,107 officers and men to which must be added 569 Auxiliary officers and men. The number continued to grow from that time until the war.

I have mentioned our continued interest in methods of starting aero-engines under winter conditions. These same considerations led Tommy Siers, then superintendent of maintenance for Canadian Airways, to be interested in the Worth oil dilution system that was being used by the United States Army Air Corps.

In the RCAF we had been using oil of low viscosity for cold weather flying. The object was to be able to turn the engine over fairly easily and get a good start. Once in the air we relied on large oil coolers to keep the viscosity of the oil as high as possible. This method was not liked by the engine manufacturers, but I do not recall we ever had any engine trouble due to the use of light oil.

With the Worth system, the oil was diluted with gasoline before the engine was shut down so that when the engine was started again it would be lubricated with light, or rather diluted, oil of low viscosity. Then after running for a short time the gasoline would be evaporated and the oil restored to its original viscosity. If it could be made to work satisfactorily it had advantages over using light oils because when the engine was fully warmed higher viscosity oil was desirable.

After investigating this new system, Siers arranged for tests to be made in Canada in 1938. Results were satisfactory and this system was adopted widely not only by commercial operators, but also for RCAF aircraft.

For his enterprise in investigating and applying the idea, Tommy Siers was awarded the McKee Trophy for the year 1940. The McKee Trophy is awarded annually to the person judged to have contributed most substantially to the progress of aviation in Canada in any given year. I had the pleasure of presenting this trophy to Tommy Siers, on behalf of the Minister of National Defence, in Toronto in 1941. Tommy Siers was at that time acting for the Department of Munitions and Supply in supervision of aircraft overhaul.

I have record of the use of the oil dilution system on a number of RCAF machines: The Bolingbroke, Hudson, Battle and the Yale. Drawings were made for these installations in the RCAF drawing office during 1940 and 1941.

In 1937-38 the vote for the RCAF was $11,391,650 and for Civil Government Air Operations $361,000. By this time the Department of Transport had been formed and provided about $2,000,000 for civil aviation and the establishment of airports. The appropriations for 1938-39 were of the same order. During this year No. 4 Repair Depot was opened at Dartmouth.

First Hurricanes Arrive

Early in 1939 we received our first Hurricane fighters as replacement for the Siskin, now quite obsolete. During the war Hurricanes were produced in Canada by the Canadian Car and Foundry Company at Fort William. Miss Elsie MacGill was chief aeronautical engineer of the company at that time.

At an Imperial Conference, in 1936 I believe, the decision was made that the RCAF squadrons should be equipped with British Aeroplanes and engines, so that all logistic and training questions would be simplified. In theory this looked to be a good arrangement. Subsequent events proved that it had its drawbacks.

It was very nice for the British aircraft industry to have the RCAF as a customer in slack times, but when war was declared we found ourselves in the position of having only the smallest number of service aircraft, and with no industrial production of aircraft engines.

Supplies Cut Off

Great Britain, our source of supply, was fully occupied with her own problems of manufacturing the aircraft and engines required for the RAF and certainly could not supply us with any equipment of this kind. On the contrary, Britain was only too pleased to have the service aircraft we possessed sent over to assist in the Battle of Britain. Our other possible source of supply, the United States, was temporarily cut off by reason of its Neutrality Act.

As a result we were left without any aircraft for defense purposes. Luckily we were not threatened at home, but we cannot assume that the same conditions will always apply.

In September, 1938, at the time of Hitler's threat against Czechoslovakia, war in Europe seemed imminent. It was realized that we in Canada were seriously handicapped by our shortage of service aircraft. Although the appropriations for the RCAF had been increased, they did not permit the emergency purchase of any additional service aircraft.

I was not personally involved in the discussions that led to the decision, but I was instructed, on very short notice, to accompany the Senior Air Officer, George Croil (Air Marshal G. M. Croil, AFC, Ret.) on a mission to Washington to purchase aircraft.

We were accompanied by Gordie Truscott (now Group Captain RCAF) as Staff Officer. Arrangements had been made that we were to have a cash credit in a New York bank and that the aircraft were to be bought for cash and with the earliest possible delivery.

Instructions had been sent to the Canadian Embassy and when we reported to the Hon. Sir Herbert Marler, the Canadian Minister at Washington, we found he had been fully informed on the purpose of our visit.

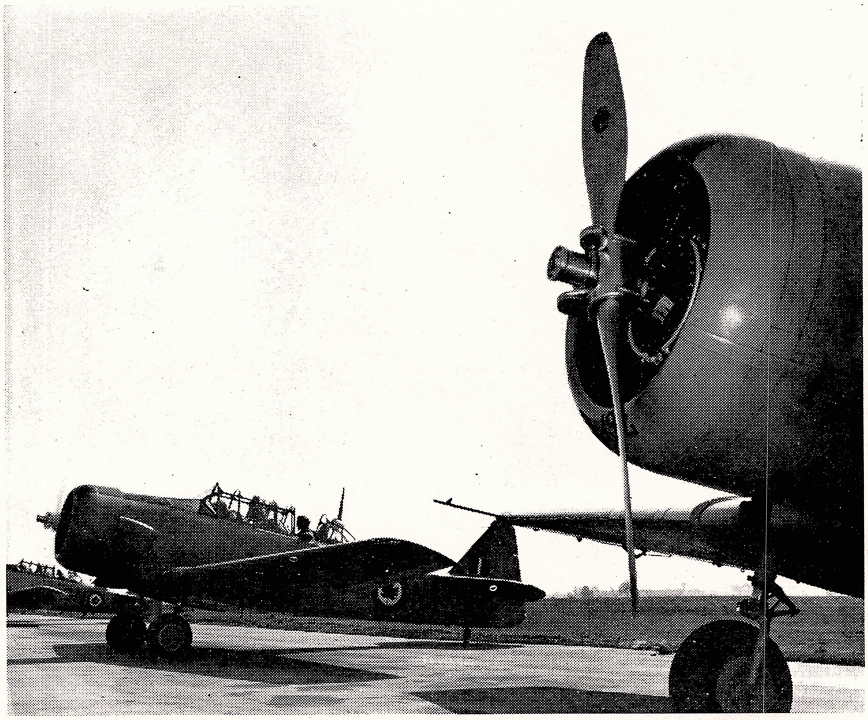
One does not buy service aircraft across the counter and no manufacturer carries a stock of completed service aircraft available for immediate delivery. It was obvious that our only possible sources of supply would be those made available to us by the United States government.

I do not propose to go into detail about the many meetings that took place with Senior Army and Navy Officers and with the Secretary of War. Sir Herbert Marler demonstrated his very considerable influence and his diplomatic skill which resulted in the accomplishment of what had seemed to be impossible. Arrangements were made for us to take delivery of a number of fighters, bombers and flying boats from manufacturers engaged upon U. S. contracts.

"Peace in Our Time"

The negotiations had about reached finality, with concurrence from the highest U. S. political circles, when Chamberlain went to Munich. The night after his return to London with his "Peace in our time" message, Croil was called by telephone from Ottawa with instructions that our cash credit was withdrawn. We were to cancel all arrangements and return to Ottawa at once.

I presume the thinking was that the expenditure of funds in excess of those voted by Parliament for a specific purpose may be excusable in an emergency, but that when the emergency passes there is no longer any reason for hurried purchases. Everything should go through the usual governmental procedure. However, this line of reasoning did not take into account the very considerable concessions that had been made by our American friends.



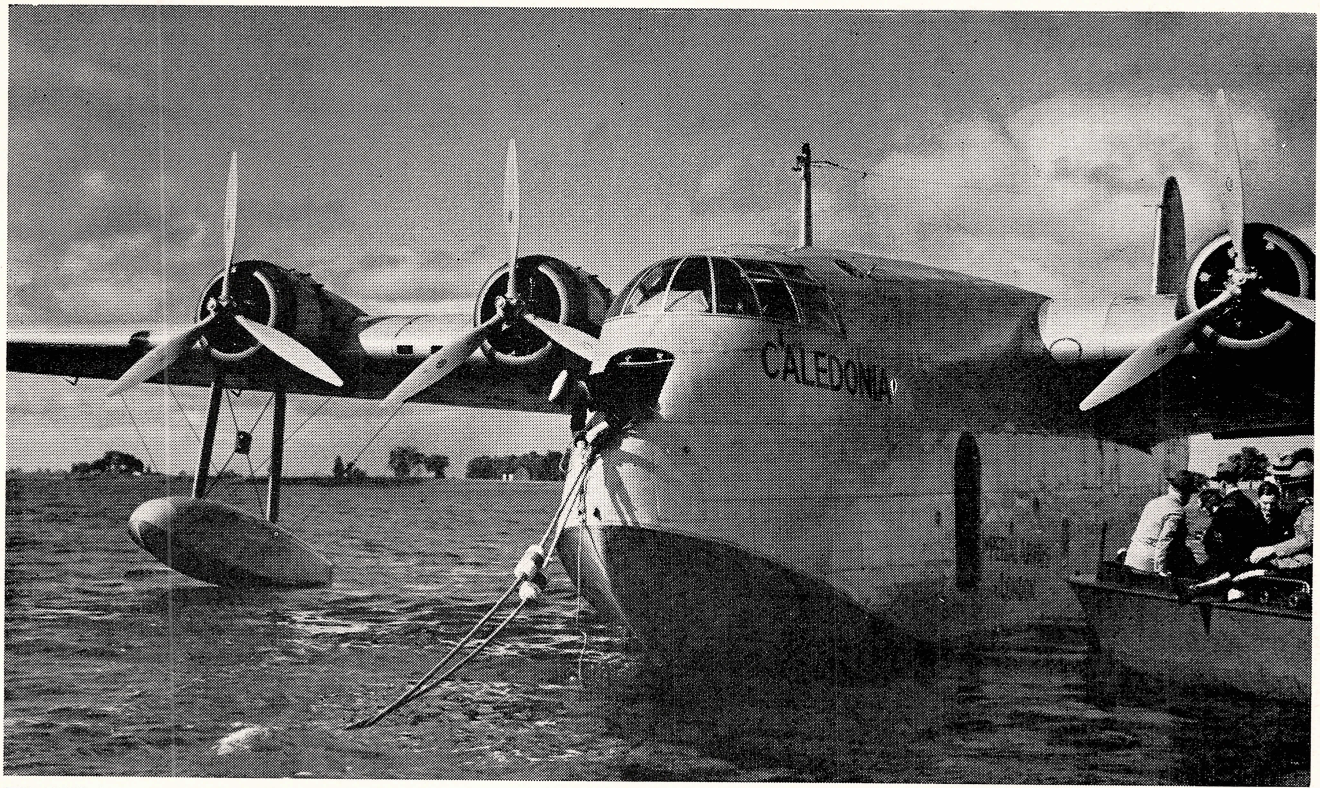
HARDY INFANT. Arrangements for the production of the Harvard trainer in Canada were made before the outbreak of the war, and these hardy machines remain in service at RCAF training schools today as the standard advanced trainer.

One can imagine the effect this message had on Sir Herbert Marler, who had worked so hard to accomplish the "sale." I shall never forget our call, the next day, on the Secretary of War when the Minister had to explain to him what had taken place. The other officials and manufacturers also found it a little hard to understand, after having worked in such feverish haste to complete the arrangements.

In less than a year, we needed these aircraft more than ever. Just before war was declared in 1939, I was told I was to go to Washington with a second purchasing mission under circumstances similar to those related above.

I at once objected that we could not approach United States authorities again without some assurance the arrangements entered into would be completed; that the undertaking would be irrevocable. After some discussion it was decided to ask R. C. Vaughan, later president of the Canadian National Railway, to head a mission, which included myself and a Stores Officer, to proceed to Washington. We were assured there would be no cancellation.

We were able to place orders for some Consolidated amphibians, Douglas bombers, and Harvard trainers, including a license for the manufacture of Harvards in Canada by Noorduyn Aircraft Limited of Montreal.



TRANS-ATLANTIC INAUGURAL. July 5, 1937, Imperial Airways Short Caledonia flying boat left Foynes, Ireland, on the first East-West Trans-Atlantic air service, being established on an experimental basis. **PanAm Sikorsky Clipper III made West-East flight** during same period. Imperial Airways crew made Botwood, Nfld., on July 6, were into Montreal two days later, on July 8.

Boxkite to Jet

Monoplane Takes the Lead

By A/V/M E. W. Stedman

In this series so far, the period from 1919 to 1939 has been dealt with in chronological order, as seen by one individual.

During these 20 years of peace, aeronautical research developed tremendously in all major countries, particularly in the United States. There was a free and rewarding exchange of information between individuals and professional societies of the various nations.

I would now like to review briefly the progress made during these years of development under the urge of international commercial competition.

The first thing that attracted attention when the aeroplane was turned to commercial uses after the first war, was the question of carrying a greater pay-load. With the low wing-loadings that had been general, the wings themselves represented a big portion of the weight. An attempt was made to carry a greater load per square foot of wing surface thus reducing the wing area and weight.

The slotted wing seemed to offer possibilities at one time since it would allow a reasonable landing speed with a high wing loading. But as mentioned earlier the large angle of attack when landing was a disadvantage. It did not come into general use.

An outstanding small machine was the Junkers, low-wing monoplane of all-metal construction. It was used in the Canadian north in 1921 and was very much ahead of its time.

In 1923 de Havilland built the DH. 34 single engined biplane, using a Napier 'Lion' engine. It carried two pilots in an open cockpit just ahead of the wing and behind the engine. The fuselage extended the full depth of the gap between the two planes and carried eight passengers.

This machine had a landing speed of 61 mph, which was considered high in those days of no brakes or flaps and grass landing fields, but it was soon accepted as satisfactory.

By 1925 the Fokker high-wing monoplane, with a plywood covered wooden wing and a welded steel tube fuselage, began to attract attention in the United States. It influenced design, as evidenced by the number of high wing monoplanes which followed.

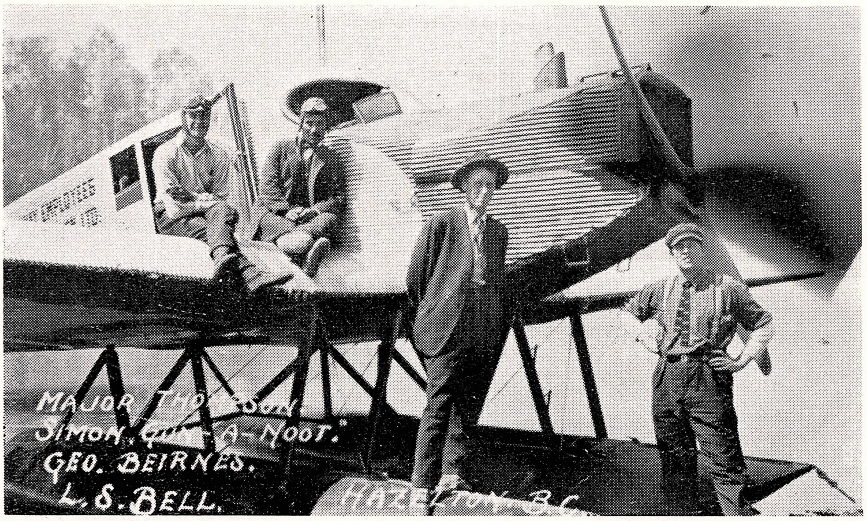
Metal hulls for flying boats began to appear about 1926. They quickly became general because they offered so many advantages over wooden hulls.

Germany again came to the fore by 1928 with low-wing metal covered, Junkers monoplanes, of different types. One of these types, the Bremen, was the first machine to fly the Atlantic from East to West.

In the United States, the Ford all-metal high-wing trimotor monoplane was attracting attention.

In England, Imperial Airways was using biplanes in 1930, but went to a high-wing four-engined monoplane by 1933.

There were now a number of important advances that we accepted without realizing too well what they meant to future designs. I refer particularly to wing flaps, wheel brakes and the retractable undercarriage. All hastened the development of aircraft as we know them today.


MAJOR THOMSON
SIMON. GUN-A-NOOT.
GEO. BEIRNES.
L.S. BELL.
HAZELTON B.C.

BUSH PIONEERS. With the famed Junkers monoplane are B. C. bush flying pioneers, left, Pilot G. A. Thompson, Simon Peter Gun-a-Noot, George Beirnes and I. S. Bell.

The wing flap made it possible to land at a reasonable speed with a high wing loading. This was further advanced by recognition of the necessity for hard surfaced runways, which were becoming available. Wheel brakes were of great value in helping a pilot to pull up when rolling along the ground and also for assistance in turning while taxiing.

The retractable undercarriage became much more practicable with the low-wing monoplane, since the undercarriage legs were comparatively short.

As late as 1934, metal covered wings were frowned upon in England because of their weight. A clever device for producing a lighter fabric-covered structure was put forward by Barnes Wallis of Vickers with his geodetic construction, used in the Wellington bomber. But this system was not retained after the war.

When the war started in 1939 the aeroplane had developed from the wood, fabric and wire biplanes of 1919 to the all-metal low-wing monoplanes of 1939, by gradual stages. But when reviewed as a whole the change represents a tremendous advance in the art of building aeroplanes.

The power plant had improved mainly as the result of the development of special fuels allowing the use of higher compression ratios. Or perhaps we might say that the use of higher compression was the reason for the development of the fuels. Both were necessary.

A great advance had been made as the result of development of the all-metal variable pitch propeller, to which our own Turnbull had contributed so much. The later development of the constant speed and reversible propeller, added greatly to the performance of aircraft which flew at much higher speeds and greater heights than at the commencement of the period under review.

Even at that time I feel we did not fully realize what had been achieved. The structure and general design of the aeroplane was now ripe for the revolutionary advance which was shortly to take place in the powerplant. I refer to the advent of the gas turbine and jet propulsion during the second war.

Over the years, we had attempted to keep pace by acquiring aircraft which incorporated these latest developments. It was not a particularly easy task, with the budget trimmed to the bone during the depression.

On the eve of war, the aircraft we possessed were 22 Wapiti, 20 Oxford, 19 Hurricanes, 13 Atlas, 11 Sharks, 10 Battle, 8 Stranraer, 4 Norsemen and 4 Vancouver; plus an assortment of other training or operational aircraft. Total strength was 270 aircraft of 23 different types.

This was the climate in which we undertook the second purchasing mission to Washington. (Canadian Aviation — August, 1960, page 31). While we awaited delivery of the aircraft we had secured we did the best we could with what was available at home.

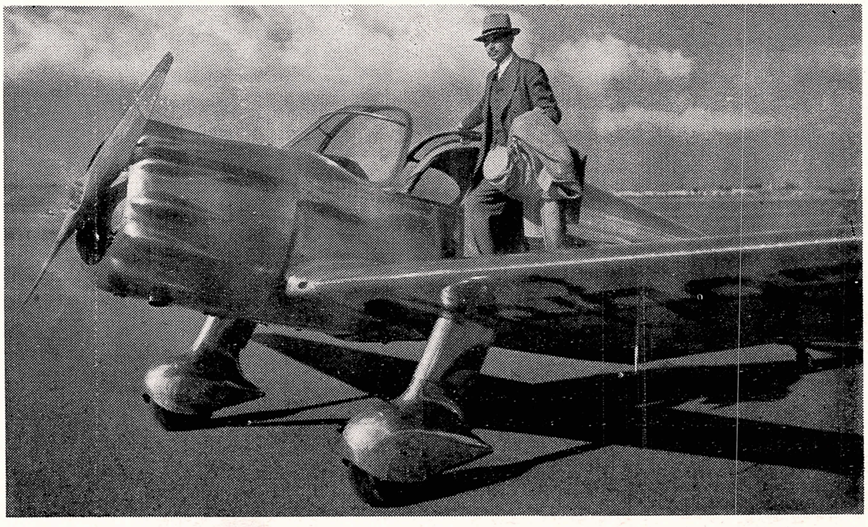
Art James and Charlie Crossland, in letters to me, both speak of working on the provision of armament for a civil type of aeroplane, the Northrup Delta, for defense purposes on the East Coast after war was declared.

Johnny Green (Dr. J. J. Green) writes about this same job, he says:

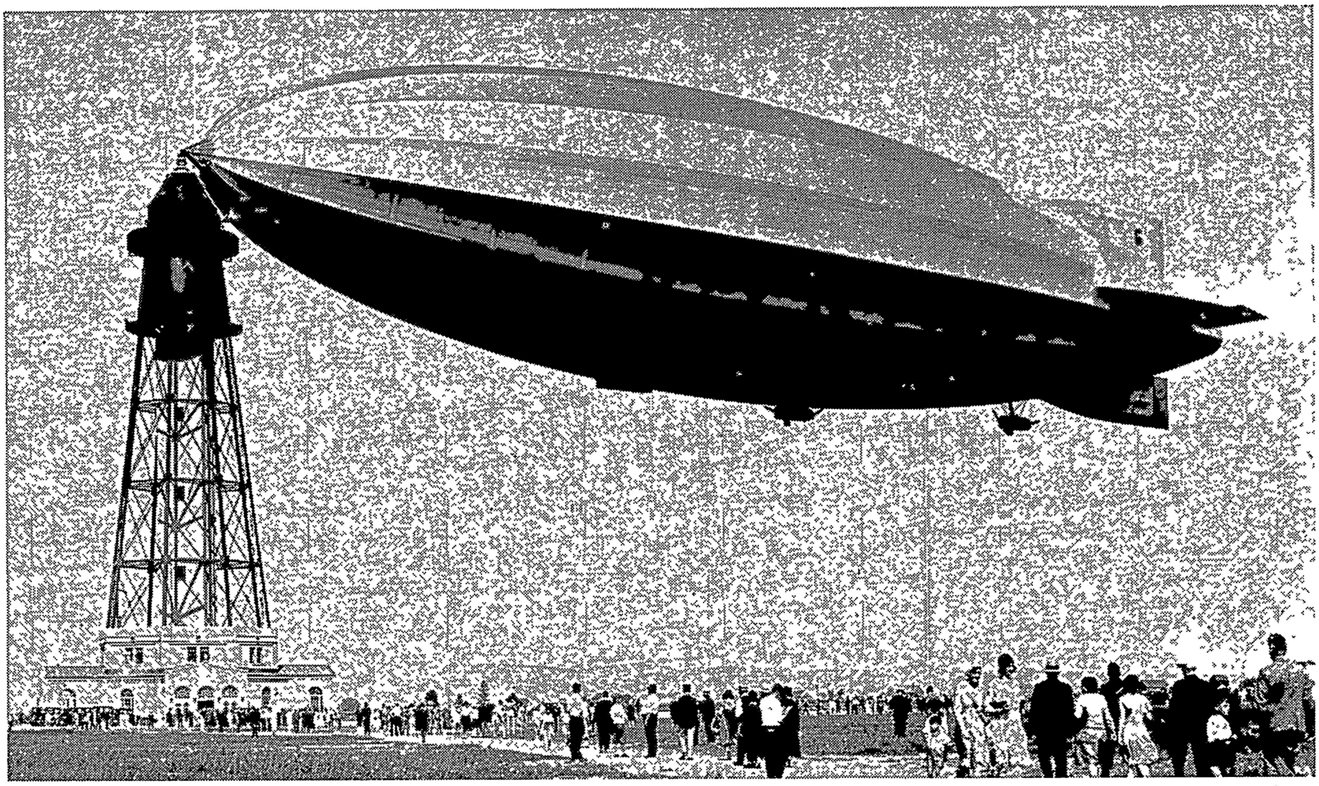
"At the NRC I was extensively involved in this work which was the first strictly military job which we did. As you know, we had at that time already built a wind tunnel model of the Northrup Delta and the addition of armament was a two-fold job. Firstly, to measure the performance deterioration due to the addition of 250 lb. bombs and if I remember rightly, a second installation involving smaller bombs of 50 lb. size. We then attempted to reduce the drag of the installation by the addition of suitable fairings.

The second aspect was the provision of a machine-gun on top of the cabin. This was to involve the cutting of the skin of the roof and the mounting of a gun ring thereon. It was necessary to provide a windshield to protect the gunner and provide him with adequate lateral movement of his gun. We tested a full-scale mock-up in the wind tunnel in order to develop a suitable windshield shape, and model tests were then made to determine the influence of the windshield on the drag.

In subsequent flight tests the windshield caused severe buffeting of the fin and rudder. This was explored in the wind tunnel . . . and modifications to the windshield were devised which effectively suppressed the buffet trouble encountered in flight."



EARLY METAL DESIGN. One of the first medium-weight cabin planes of all-metal, with full-cantilever, low-wing configuration was Ryan S-C introduced during 1937.



MONTREAL MOORING. The British airship R-100 moored at St. Huberts, Montreal, following its 3,845 mile flight from Cardington, on August 1, 1930. Repairs were made to the ship before it journeyed to Ottawa, Toronto, and back to the U.K.

From Boxkite to Jet

Disasters Ended Airship Era

Canada was visited on historic flight of the British ship R-100

By A/V/M E. W. Stedman

No account of aviation in the period between the World Wars would be complete without reference to airship development.

Following the First World War the British Air Ministry continued development of rigid lighter-than-air craft, based largely on examination of German airships shot down during the war.

By 1924 it was generally agreed that the aeroplane was not suitable for commercial flights over large stretches of ocean! It seemed desirable to develop the airship for this purpose. The rapid improvement in performance and reliability of the heavier-than-air aeroplane was not visualized and everyone had been tremendously impressed by the possibilities of the Zeppelin type airship.

At the Imperial Conference of 1926 the British Government put forward a proposal for development of the airship for communication between the Dominions and the Motherland.

There were two new airships under construction in Britain. The R-100 was being built by the Airship Guarantee Company, a subsidiary of Vickers Limited, with Sir Dennistoun Burney as the chief exponent of the use of airships. The second airship, the R-101, was being built at Cardington by the Air Ministry.

There was, unfortunately, considerable feeling between these two organizations, the government competing against the private company. This is brought out in a book published by the late N. S. Norway (author Nevil Shute) who at that time was chief engineer of the Airship Guarantee Company.

Under the proposal put forward at the conference, mooring masts were to be erected at Ismailia and in Canada at a point to be selected. The Canadian government provided funds in the financial year 1927-28 for the provision of an airship base with a mooring mast, and Major G. H. Scott and A. R. Gibbs came to choose a suitable base in Canada. They selected an area at St. Hubert near Montreal and this site was purchased in August, 1927.

K. M. Cameron, chief engineer of the Public Works Department, was charged with development of the mooring mast machinery and construction of the mooring mast itself. The mooring head for the top of the mast was constructed in England at the same time as similar heads for the other masts. It was now necessary for somebody in the Department of National Defense to learn something about lighter-than-air ships. I was sent to Europe with this in view.

Visiting both the airship works at Cardington where the R-101 was under construction and the works of the Airship Guarantee Company at Howden where the R-100 was being built, I had an opportunity to discuss details of the methods of construction. I also visited the Zeppelin works at Friedrichshafen and saw the work on the "Graf Zeppelin" which made many crossings of the Atlantic between 1928 and 1935. Later I saw this airship under test in the neighbourhood of Lake Constance.

In 1928, in company with Mr. Corriveau of the Public Works Department, I visited Lakehurst to see the preparations made for the reception of the "Graf Zeppelin" and witnessed the landing of this ship after its first voyage across the Atlantic to the United States. At about this time I was also able to visit the works of the Goodyear Company at Akron to see the construction of the United States airship Akron. This was a very interesting ship which, like so many others, was destined to come to a disastrous end, crashing into the Atlantic in 1933 with a large loss of life.

In 1919 the airship R-34 had flown to the United States and had passed down the East coast of Canada at about the same time that the Handley Page aeroplane was flying from Harbour Grace, Newfoundland, to Parrsboro, N.S. The airship crew were unable to consider stopping in Canada owing to the lack of facilities for handling an airship at the time.

The airship R-100, Captain R. S. Booth, AFC, was chosen for the first flight to Canada. This ship, built by the Airship Guarantee Company at Howden, Yorkshire, had been launched in December 1929. It was 709 feet long, 130 feet maximum diameter and had a volume of 5,600,000 cubic feet. It was powered by six Rolls Royce Condor engines carried in three power cars. Its range at 70 mph was 3,600 miles and at 60 m.p.h. was 5,000 miles in still air. Payload was 24.5 tons, including up to 100 passengers.

The Airship left Cardington in the early hours of the morning of 29th July, 1930, with 44 persons on board and 10,440 gallons of fuel. The flight was uneventful until she was well within the Gulf of St. Lawrence when rough, turbulent weather was encountered. Nevil Shute writes in his book:

"This was very bumpy, and gave us the worst motion that the ship had yet had . . . Immediately afterwards the starboard and aft cars rang for assistance and pointed out tears in the fins. I went by way of Frame 15, and found a hole large enough to drive a bus through, in the lower surface."

The speed was reduced to enable temporary repairs to be made to the fabric of the fins and then the ship proceeded at about 45 knots. A thunderstorm was passed through at 9:30 p.m. with violent air currents which caused the ship's height to vary rapidly and which resulted in further damage to the fabric on the fins.

Reg Grant has some interesting notes on the visit of the R-100. He writes:

"You sent me to Montreal to get the fuel system on the mooring mast in working order and to collaborate with the Montreal Branch of the Imperial Oil Company in provision of petrol to the British specification. The first part of the assignment might have ended disastrously. I asked Imperial Oil to put a tank full of commercial gasoline into the underground storage tank to flush this out as well as to test the fuel system to the masthead and airshop refuelling point. I remember it was a pouring wet Saturday afternoon with big puddles of water around the base of the mast.

"All seemed well in the delivery of fuel to the mas head, but when we reached the ground again the smell of petrol was much stronger than it should be and on further investigation it was found that the puddles were now well mixed with petrol, the transfer air pressure having forced it out of an underground leak. Fortunately there was nobody around to smoke. The oil company brought in more tank trucks and a pump and pumped up the puddles as well as the residue of fuel in the tanks. They had done a tremendous amount of work in trying to match the British specification and in finally preparing and supplying the fuel needed.

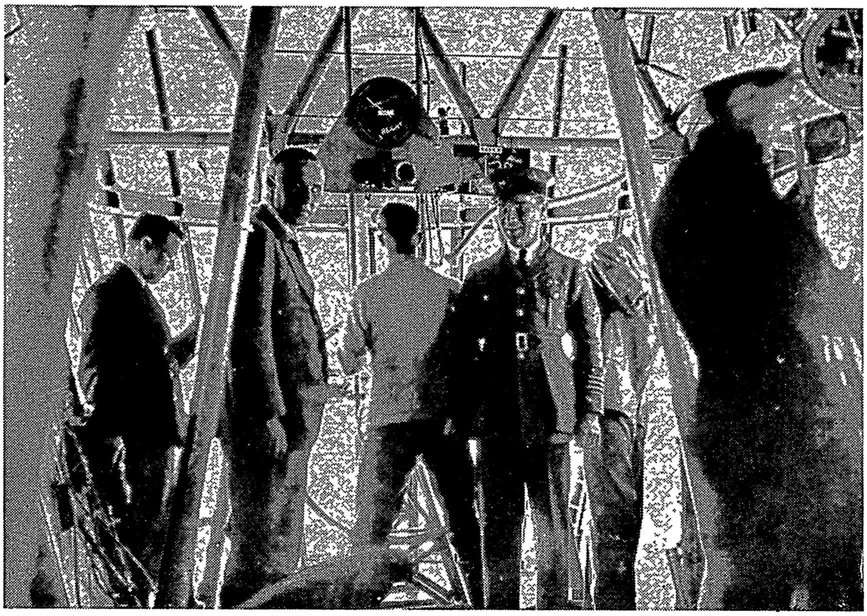
Repairs by Vickers

The ship arrived at St. Hubert at 4:30 a.m. on August 1st, 1930, having covered a distance of 3,845 miles in 78 hours, 52 minutes. Repairs to the fins were started at once and Canadian Vickers made some large pieces of fabric provided with tapes for attachment to the structure of the fin surfaces. Reg Grant rendered great assistance during this rush repair job. The fabric patches were fitted to the fins by the crew of the airship, at the mooring mast. In a few days the ship was once again ready for service.

On August 9th the airship left Montreal for a flight to Ottawa and Toronto with 14 senior Canadian officials as passengers. We passed over Ottawa about 10 p.m. and Toronto and Niagara Falls the next morning, arriving back at Montreal on the evening of the 10th.

When returning to the mast at Montreal, there was some trouble with the reduction gear of one of the engines with the result that a part of the metal sheathing of one of the propellers flew off and damaged one of the booms in the hull of the airship. At the time we, the passengers, knew nothing about this, but we heard about it next day when the question of changing the damaged engine came up. The boom was patched but it was not possible to change the engine because some necessary equipment had not been sent out from England. This meant that the airship would have to return to England with only five of its six engines in operating condition. This was not considered to be serious in view of the prevailing West to East winds.

The return flight to England was commenced at 9:30 p.m. on August 13th, 1930. The passenger list included: Group Captain R. B. Colmore, Director of Airship Development; Major G. H. Scott, Assistant Director (Flying); Sir Dennistoun Burney; N. S. Norway, Chief Engineer, Airship Guarantee Company; Wing Commander I. J. Twistleton-Wykeham Fiennes, Air Attache at the British Embassy, Washington; Group Captain E. W. Stedman, Chief Aeronautical Engineer, Department of National Defense, Ottawa; Thomas Wayling, Southam Press; Jacques Cartier, repre-



R-100 CONTROL CABIN. The rather crude instrument panel of the airship can be seen in this view, and through the cabin windows, outline of the terrain below. The author (then a Group Captain) (right centre) was among those who flew in the R-100.

PROMENADE DECK. The airship afforded opportunities for relaxed appreciation of the scenes below denied by the airplane. Remote positioning of the engines made the cabin pleasantly quiet, and the mobility afforded the passengers was luxurious.

senting French language press; C. H. J. Snider, Toronto Telegram; Don. C. Brown, Toronto Mail and Empire and Winnipeg Free Press; S. Boulton, Yorkshire Post and Times of India; Fergis Grant, Montreal Gazette; M. Slater, London; E. Glyn Jones, Reuters, London.

The total number of persons on board including crew is given as fifty-five. Around midnight, local time, we passed over Quebec. I remember particularly that as we passed over one small town somebody flicked on the lights at some tennis courts in welcome.

Belle Isle was passed near noon, local time, on the 14th. Later that day we ran into a gale. The passengers were quite oblivious to these conditions because there was nothing unusual in the motion of the ship itself, but the navigator told us that we were not making very good progress. I was helping to plot meteorological information and it was obvious that there were insufficient reports from mid-Atlantic to enable us to determine where the centre of the storm was; all the reporting ships seemed to be near one coast or the other. The next morning more reports were received and the navigator was able to shape our course so as to take advantage of the wind.

During the storm there had been very heavy rain and a great deal of water had penetrated the outer cover, saturating things. It was thought that some of this water might have shorted some of the electric wiring, so it was decided that the cooking devices in the kitchen should not be used. From that time we had no hot food or drink.

The passenger accommodation consisted of a large saloon where meals were served. This communicated with promenade decks on each side of the ship inside the outer cover. There was a rail on the outer side of the deck and when leaning on this rail, one could see downwards through the sloping windows.

From the promenade decks, steps led up to the cabins which were arranged over the saloon and immediately below the gas bags. The cabins had two-tier bunks and canvas walls and ceiling. There were no hooks for clothes, so everything went in a heap on the floor. Sleeping was easy and comfortable in the sleeping bags provided. There was little noise, because the engines were in nacelles outside the hull of the ship.

Movement was Hazardous

As a service member I was perhaps given a little more freedom of movement and was able to visit the navigator's hatch at the top of the hull near the fore end. This was reached by climbing up a very narrow wire-rope ladder vertically for about 80 feet. I also visited a hatch at the top of the fin post which was reached by climbing up the girder work inside the fin structure. I was very interested to see a member of the crew walking along the top of the hull on the outside inspecting the outer cover. There was a safety cable lying along the cat walk but he did not seem to use it.

During Friday, 15th, we passed quite low over a Canadian Pacific freighter presumably for the purpose of checking our position with the ship's officers. Early in the morning on Saturday, the 16th, we passed over Lundy Island and shortly after we were welcomed by an aeroplane flying from the neighbourhood of Bristol.

We landed at Cardington about 10 am, August 16th. The small welcoming party was in marked contrast to the large crowds that had gathered at Montreal during the visit of the airship. Most of the people were the relatives of members of the crew.

The approximate time for the flight was 57 hours at an average speed of about 58 mph made good. This was the last flight made by the Airship R-100. It was placed in its shed at Cardington and following the later decision to discontinue the use of airships, was dismantled.

In his speech of welcome Lord Thomson, Secretary of State for Air, said: "I welcome you home from Canada and congratulate you on having accomplished this first stage in the development of British airships, whose contribution to our Imperial air communications must be of incalculable significance."

It should be noted that at that time nobody was inclined to disagree, showing how difficult it is to foresee the direction in which development will proceed.

Shortly after this the airship R-101 started on a flight to India, leaving Cardington at 6:30 p.m., on October 4th, 1930. This is not the place to go into details of this flight, but we know that it ended in disaster at Alonne near Beauvais in northern France in the early hours of the morning of October 5th. Of the 54 persons on board, only six survived, four of them engineers in the power cars.

This disaster took the lives of a great many of the men who were experienced in airships and wrote finish to the idea of using lighter-than-air ships for Imperial air communication.

In the United States the accidents with their airships and the burning of the Von Hindenburg at Lakehurst in May, 1937, were among the factors that led to the abandoning of any large rigid airship program. Some small, non-rigid, helium-filled airships are still used in a minor way.

By the end of 1930 it was becoming evident that the limitation placed on the possible use of aeroplanes for long distance, overseas flights was quite in error. From 1931 many long distance flights were made to different parts of the British Commonwealth both by flying boats and land planes. The further use of airships was eventually completely abandoned in the light of increased performance with fixed wing aircraft.

The mooring mast at St. Hubert stood unused for several years. It was finally demolished in 1938, being regarded as a hazard to flying in the neighbourhood of the St. Hubert aerodrome.

When the airship R-100 was dismantled in 1931 one of the steering wheels was presented to J. A. Wilson. This wheel is now in the museum of the National Aeronautical Establishment at Uplands in Ottawa.

From Boxkite to Jet

War Clouds Gather, Empire Air Training Plan is Launched

By A/V/M E. W. Stedman

In an earlier chapter I referred to our frantic efforts at re-equipment as the war clouds darkened in the late summer of 1939.

Canada declared war with Nazi Germany on September 10th, 1939. On September 26th the British Government proposed to the governments of Canada, Australia and New Zealand that consideration should be given to the question of training aircrew personnel in Canada. It is probable that there were some who remembered the training done in Canada during the 1914-18 war.

A Commonwealth conference was held in Ottawa to go into details of this question. Delegates arrived from the countries concerned. The British party included: Rt. Hon. Lord Riverdale; Capt. H. H. Balfour, Under Secretary of State for Air; Sir Gerald Campbell, High Commissioner; Air Chief Marshal Sir R. Brooke Popham; Air Marshal Sir C. Courtney; Group Capt. J. M. Robb; Group Capt. A. Gray; Group Capt. L. N. Hollinghurst; J. B. Abraham; J. R. Smith; F. R. Howard.

The Australian party consisted of: Hon. J. V. Fairbairn, Minister for Air; Wing Commander G. Jones, Assistant CAS; C. V. Kellway; R. E. Elford. The New Zealand delegation was: Group Capt. H. W. L. Saunders, Chief of Air Staff; T. A. Barrow; W. L. Middlemass.

Before the full conference, preliminary discussions were held by members of the Canadian cabinet and senior RCAF officers to get some idea of what we thought we could do. Our ideas did not measure up to the farseeing proposals brought by the British delegation.

The Canadian members of the conference included: —Rt. Hon. W. L. Mackenzie King, Prime Minister; Hon. Senator R. Dandurand; Rt. Hon. E. Lapointe, Minister of Justice; Hon. N. M. Rogers, Minister of National Defense; Col. the Hon. J. L. Ralston, Minister of Finance; Hon. I. Mackenzie, Minister of Pensions and National Health; Hon. C. D. Howe, Minister of Transport; Dr. O. D. Skelton, Under Secretary of State for External Affairs; Dr. W. C. Clark, Deputy Minister of Finance; Lt.-Col. K. S. MacLachlan, Deputy Minister of National Defense; Air Vice-Marshal G. M. Croil, Chief of Air Staff; Air Commodore E. W. Stedman, Air Member for Engineering and Supply; A. P. Heeney, Principal Secretary of the Prime Minister.

Plan was Ambitious

I have every reason to remember the first meeting of the conference. In the first place, the scheme put forward by the British party was so far ahead of anything we had contemplated that everyone who had not heard details before was taken aback at its magnitude. I must pay tribute to the wisdom of the scheme, which later proved essential for the conduct of the war.

I was sitting a little to one side of and behind the Prime Minister. When Lord Riverdale outlined the plan I could see from the Prime Minister's expression that the proposal was far beyond anything that we or he had in mind. I was impressed that he did not show any sign of surprise or give any indication that what was happening was anything out of the ordinary.

Then the question: "How much is it going to cost?"

Everyone looked to George Croil. It was decided that the conference should meet again in a number of days when the RCAF would supply an estimate of the cost. I have forgotten the number of days that we had to prepare this estimate, but it was far too few. On the other hand, this large number of delegates could not be kept waiting for too long a period.

The preparation of this estimate was a major piece of work for Air Force Headquarters. The British officers were well versed in training requirements and were able to supply our training people with figures for the flying hours required on different types of aircraft for the various stages of training. They were also able to supply figures for the radios of navigators, wireless operators, gunners, etc. compared with the number of pilots.

Taking an assumed number of people to be trained, it was now necessary to figure out the number of instructors in different categories and the ground crew necessary to carry out this training. Also we had to calculate the number of aerodromes that would be required and other items.

Once the plan had been worked out, it was turned over to my department for costs on all the equipment, aerodromes, fuel, clothing, overhauls, etc. that would be required. At the same time the personnel branch was busy working out the cost of such things as pay and allowance, travelling expenses, etc. for all the personnel involved. I was grateful for the good work performed at this time by Dave MacKell (now A/C D. E. MacKell, CBE, CD, retired) who produced the figures for personnel whenever they were required, often in the middle of the night.

My job did not end with providing the figures produced by the many able officers and airmen in my own department. I was responsible for consolidation of the estimates from the other departments into the final form and producing a large number of copies for the use of the delegates.

The estimate took the form of large sheets of figures giving the detailed cost of the various items. These sheets had to be photostated and bound into a suitable folder. The work of collecting the copies, arranging and binding them was done by F/S F. N. Brooks who for many years had looked after my technical files and who is specially mentioned here because I shall probably not have occasion to mention him elsewhere in these memoirs.

This work of binding the estimates was the last thing to be done, and always seemed to occur in the early hours of the morning. Altogether this was a hectic time which involved nearly everybody at headquarters. But the work was well done and the estimate produced was as accurate as could be expected at that time, when almost all figures were guesswork based on experience.

Billion Dollar Estimate

The conference met at the specified time and the first estimate, dated October 23rd, was considered. I remember that the session was not long under way before it was decided that the scheme as proposed would cost, over a three-year period, more than could be approved. This cost was estimated to be nearly $1,000,000,000, of which $400,000,000 was for capital costs.

A downward revision of the scheme was necessary. After details of this had been agreed upon, I was asked when a new estimate could be ready. This new estimate was not so difficult since we had already made our guesses for such things as the cost per flying hour on different types of aircraft, etc. All that was necessary was to rearrange the figures to suit the new proposal. This second estimate, dated November 16th. came to $686,000,000, of which about $283,000,000 was for capital costs.

The proposal reached the point when some agreement was in sight. But as a result of detailed study of the new figures, certain changes were required and a new estimate of the cost called for. The third estimate was dated November 26th and involved many adjustments, including some reduction in the number of establishments required. It amounted to $607,000,000, of which $245,000,000 was for capital expenditure.

Work Deemed Historic

By this time my staff and I were about worked out. It was no little relief to us all that the third estimate was accepted. It interested me, some two or three years later, that when I asked one of the senior financial advisors for the training plan how the estimate was working out he said that they were still using Stedman Estimate No. 3. The original copies of these estimates with many of the work sheets, giving the assumptions made, are available in the office of the Air Historian.

An interesting sidelight occurred when the question of the division of the costs between the different countries was being considered. We had tentatively divided the cost in proportion to the number of trainees sent by each country, except that Great Britain was to make contributions 'in kind' by supplying engines, airframes and spares.

One delegate raised the question of what would happen if his country found that they could send more trainees than had been estimated; would they also be required to provide more money. It was a nice question and the answer was very diplomatic.

It is not my intention to write the history of the Air Training Plan which contributed over 131,000 trained personnel to the various air forces. Obviously, that must be done on a much larger scale that can be considered here and most of it does not come within my province. Several summaries have been written, but the story is worthy of fuller treatment, with more emphasis placed on the personnel side rather than on the statistics.

After a few weeks, details of the plan had been completed and an agreement was signed in the Prime Minister's office on Sunday, December 17th, 1939. The agreement was to remain in force until March 32st, 1943. The first school opened at the end of April, 1940, and practically all the schools were opened by the end of September 1941, ahead of schedule.

The trend of the war in Europe and at sea was such that the supply of equipment from Britain was unsatisfactory and more and more equipment was provided from the United States and from the Canadian industry, which was rapidly expanding to meet the requirement. The history of the development of Canadian industry is found in the "History of the Department of Munitions and Supply".

At the outbreak of war, the RCAF had 24 aeronautical engineering officers and about 1,000 technical NCOs and tradesmen. This nucleus was augmented by engineers and technicians who volunteered their services and upon whom the bulk of the work of maintaining the equipment of the schools devolved. The task was made more difficult because of the unsatisfactory supply of spare parts and tools for our very varied assortment of aircraft and engines. The fact that the training proceeded smoothly reflects credit on the work performed by these volunteer workers.

This raises a question that always occurs at such times. The production people are rightly concerned that the output of complete aircraft and engines shall be as great as possible. The operating people need large quantities of spare parts to keep the equipment they already have in operation. But any material and working hours devoted to the production of spare parts causes a consequent reduction in the output of new aircraft or engines.

Ribs Made at Front

The position was just the same during the first war. Towards the end of the war I was in command of No. 4 Air Supply Depot at Guines in North France when Lord Weir, who was in charge of aircraft production, visited us. He was surprised to find us using able-bodied service personnel to make ribs for Sopwith Camel biplanes.

The same type of rib was made by girls in England! I explained that spare ribs were always very difficult to obtain and were always in short supply. When we had machines held up for ribs, it was necessary to make them ourselves, otherwise our output of aircraft would be held up, and we, being in touch daily with the squadrons on the line, knew how urgently these aircraft were needed.

At about the time the Commonwealth plan was building up, the Supply Branch was separated from the Engineering Branch by the appointment of Stan. Tackaberry as Air Member for Supply.

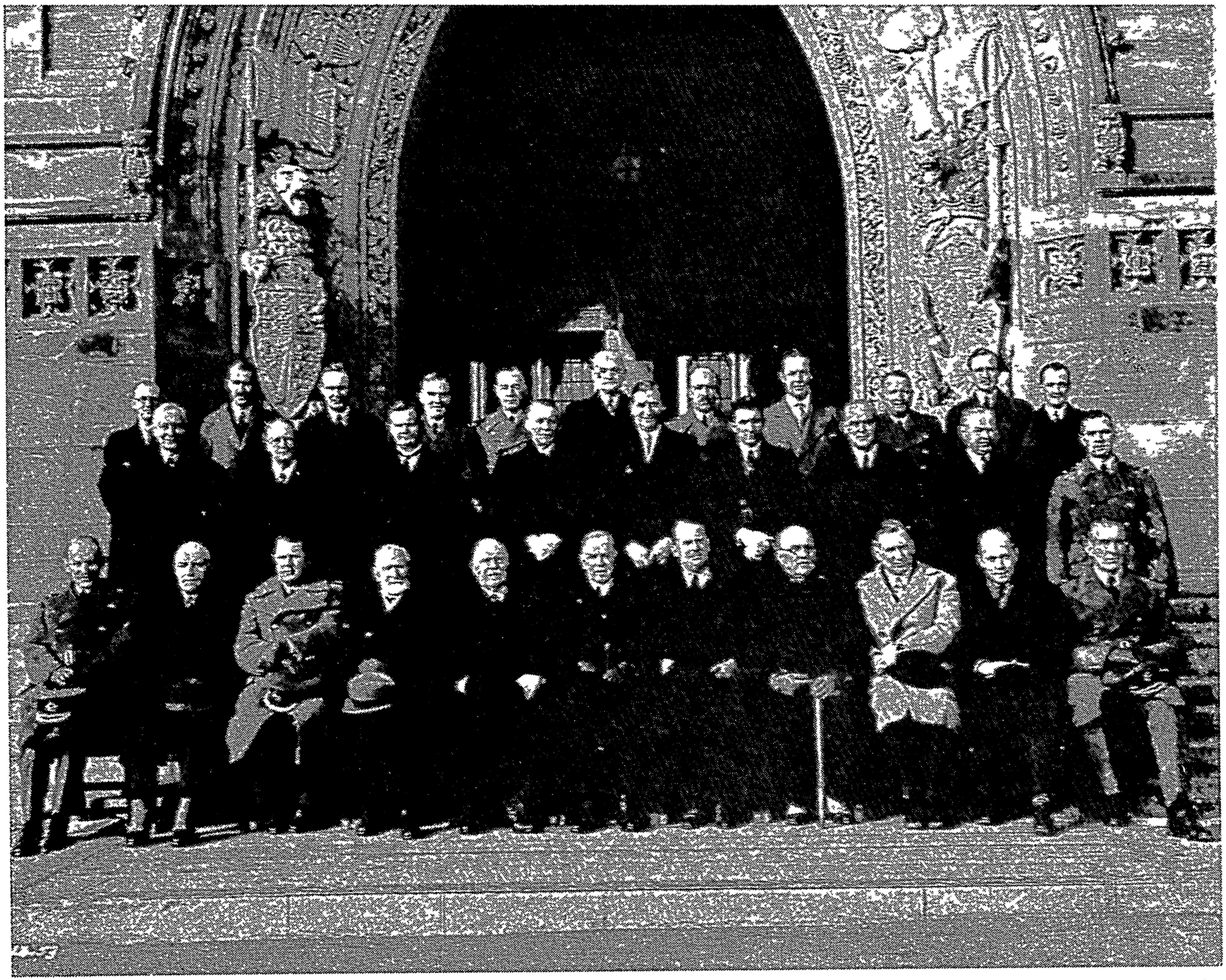
First Graduation—1940

The first draft of BCATP graduates, 12 officers and 25 sergeant observers, arrived at Liverpool on November 24th, 1940, after graduation from No. 1 Air Navigation School at Trenton on October 24th. In December, 1940, I accompanied the CAS, Lloyd Breadner (the late Air Chief Marshall L. S. Breadner CB, DSC), to Britain to visit the RCAF personnel and to confer with Air Ministry officials. On January 18th, 1941 the Air Council gave a luncheon for us at the Savoy Hotel with the Right Honorable Sir Archibald Sinclair presiding. At this luncheon a number of the members of the British delegation to the Air Training Conference were present.

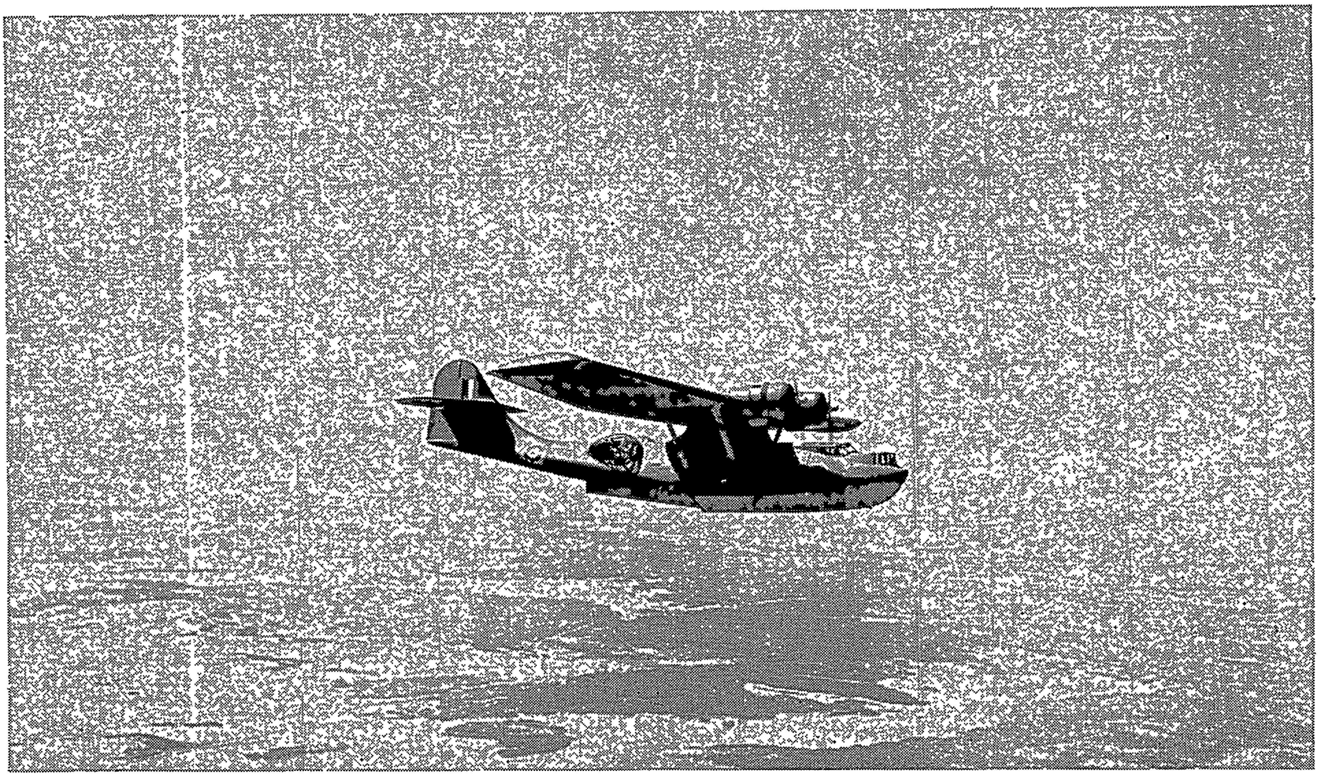
Made Research Director

The great advances being made in aeronautical research led to the creation in March, 1942, of a Director General of Air Research and I was appointed to this position. Alan Ferrier became Air Member to Aeronautical Engineering. In this new position my duties were to keep in touch with research and development that was taking place in Great Britain, the United States and in Canada and to report to the Air Council. Later, in 1945, the title was changed to Air Member for Research and Development thus giving me closer contact with Air Council.

My duties included visits to many of the training establishments for the purpose of lecturing to instructiors and pupils on developments that were taking place in the equipment they would be using and the enemy equipment they were likely to encounter. Some of these developments will be discussed in later chapters.



TRAINING PLAN FOUNDERS. Delegates to the Commonwealth conference called in Ottawa in September, 1939, to plan details of the Commonwealth Air Training Plan. Pictured on the steps of the Parliament building, they are, front row, left to right: A/C/M Sir R. Brooke-Popham, U.K.; Col. the Hon. J. L. Ralston, Minister of Finance, Canada; G/C H. W. L. Saunders, Chief of Air Staff, New Zealand; Hon. Senator R. Dandurand, Canada; Lord Riverdale, U.K.; Rt. Hon. W. L. Mackenzie King, Prime Minister of Canada; Hon. J. V. Fairbairn, Minister of Air, Australia; Rt. Hon. E. Lapointe, Minister of Justice, Canada; Capt. H. H. Balfour, Under Secretary for Air, U.K.; Hon. N. M. Rogers, Minister of National Defence, Canada; A/M Sir C. Courtney, U.K. Second row; J. B. Abraham, U.K.; Dr. O. D. Skelton, Under Secretary of State for External Affairs, Canada; T. A. Barrow, Air Secretary, New Zealand; Sir Gerald Campbell, High Commissioner for the U.K.; Hon. Ian Mackenzie, Minister of Pensions and National Health, Canada; W/C G. Jones, Assistant Chief of Air Staff, Australia; Hon. C. D. Howe, Minister of Transport, Canada; Dr. W. C. Clark, Deputy Minister of Finance, Canada; A/V/M G. M. Croil, Chief of Air Staff, Canada. Back row: J. R. Smyth, U.K.; F. R. Howard, U.K.; C. V. Kellway, Australia; A/C E. W. Stedman, Canada; G/C A. Gray, U.K.; Lt. Col. K. S. MacLachlan, Deputy Minister of National Defence, Canada; G/C J. M. Robb, U.K.; A. D. P. Heeney, Canada; G/C L. N. Hollinghurst, U.K.; R. E. Elford, Australia; W. L. Middlemass, New Zealand. *(National Film Board photo.)*



CANADIAN PRODUCED Cansos, known in the U. S. as the Catalina, have served the RCAF since early in world war II.

From Boxkite to Jet

War Spurs Aviation Advances

By A/V/M E. W. Stedman

My duties as Director General of Air Research and later as Air Member for Research and Development involved keeping in touch as much as possible with the research and development work being done in Canada, the United States and Great Britain. My purpose was to keep the Air Council informed on equipment likely to be available in the near future.

In Canada, a great deal of the work was handled by the Associate Committee for Aeronautical Research, of which I had been a member for many years. Some important work was dealt with by the comparatively new Associate Committee on Aviation Medical Research, which had been started by Sir Frederick Banting.

Much of the work for the Air Research Committee was carried out by the division of mechanical engineering of the National Research Council, under John Parkin, and has been described in a report of their war activities. I shall mention only a few of the problems that were handled, these being the ones with which I had closest contact.

In Britain and in the United States I had access to all research establishments and aircraft factories. As a result I could visit any of the establishments occupied with projects likely to be of interest and value to the RCAF.

I was well acquainted with details of all experimental aircraft and engines in both countries. By frequent visits I was able to follow their development through the experimental stage to production.

It is plainly impossible to discuss many of these items. Therefore I include only such things as particularly attracted my attention or had some special interest for me.

Revealed Secrets to U.S.

In August, 1940, before the United States entered the war, the British government decided to send a mission of leading scientists in touch with war experience and requirements to the United States to reveal this secret information to United States personnel.

The mission was headed by Sir Henry Tizard, the first chairman of the Committee of Research on Air Defense, and included Colonel F. C. Wallace who had seen action in the retreat to Dunkirk. Col. Wallace has since contributed much to radar development in Canada first in the radio branch of the National Research Council and later as vice-president of Research Enterprises Limited.

Other members were J. D. Cockcroft (now Sir John Cockcroft) who became Director of the Atomic Energy Plant at Chalk River; R. H. Fowler who was liaison officer in Canada for the Director of Industrial and Scientific Research; Dr. E. G. Bowen who became British Liaison Officer at the United States Radiation Laboratory; Captain Faulkner representing the Royal Navy; Group Captain Pearce who had had considerable operational experience and who represented the Royal Air Force.

Canada was invited to nominate three members to join the mission. These were the late General Ken Stuart (with Maj.-Gen. H. F. G. Letson, Military Attache at Washington, as an alternate); Dr. C. J. Mackenzie, President of the National Research Council; and myself, then Air Commodore and Air Member for Aeronautical Engineering and Supply in the RCAF.

Dr. Mackenzie and I joined the

others in Washington and the Canadian members of the mission were at once given the opportunity of studying in detail the folders containing the secret information brought from England.

To me the most interesting information was that dealing with radar for the detection of aircraft, which had been developed as the result of Dr. Watson Watt's observation that clouds would give a signal on a radar screen and which had been invaluable in the Battle of Britain. Many present day aids to navigation owe their origin to the work started during the war under pressure of necessity, and as a result of the work of this mission.

An account of the work of this mission has been well described in Wilfred Eggleston's Book "Scientists at War".

Proximity Fuze "Decisive"

My interest in the proximity fuze, which was not actually in my own field, dates from the Tizard mission which outlined the necessity for such a device. It was, therefore, a pleasure for me, when visiting Toronto, to see the work being done by Dr. Arnold Pitt of the University of Toronto and also the corresponding work being done in the United States. It was really a self-contained radar set assembled into the fuze of a shell. The problem of designing such a device was one of great difficulty.

At that time, we knew nothing of the "buzz-bomb", which was later defeated largely as a result of the use of the proximity fuze in anti-aircraft shells.

In the United States the proximity fuze went into large production and proved to be decisive in the battle between the United States fleet and Japanese bombers and suicide pilots as well as in other fields of battle.

I have spoken of the original laboratories of the National Research Council that were fitted into the buildings of the Edward's Mill at John Street, Ottawa. These were becoming inadequate and in addition there was pressure to remove these buildings, necessitating the acquisition of a new site.

The project had been started in 1938, under General A. G. L. McNaughton, then President of the National Research Council. In the following year a tract of 133 acres, adjacent to the RCAF station at Rockcliffe, had been acquired and fenced.

First to be erected was the aerodynamics building, the corner stone of which was laid by the Honorable W. D. Euler on July 23rd, 1940. This building contained a new horizontal wind tunnel and a vertical spinning tunnel, the first tunnel of its kind in Canada.

In dealing with the work done in the aerodynamics branch during the war G. S. Levy writes:

"At the request of the RCAF certain subjects such as large load carrying gliders, helicopters and robot weapons were studied in order that if the need arose, work on these subjects could be immediately undertaken.

"In the early part of the war, a preliminary design and performance estimate of a long range stratosphere bomber was requested by the Air Council, and although no aeroplane along these lines was built in Canada some present large bombers are similar to what was then considered."

The very complicated problem of the balancing of aircraft controls was studied and several reports were issued which had an application to aircraft in use.

The spinning tunnel was used to investigate the spinning characteristics of a number of aircraft. For instance at one time it was suspected that certain accidents with the Cornell training aircraft were caused by some defect in the design of the aircraft. Tests in the spinning tunnel agreed with flight tests and it was concluded that the aeroplane did not require modification.

Mr. Levy also writes:—

"A thorough investigation of the spinning characteristics of the tailless glider being built for flight tests was undertaken. The spinning tunnel proved to be suitable for spinning larger models than possible in other tunnels, and a research on the effect of the size of the model on the predicted spin characteristics was initiated.

"Besides the work in the tunnel, analyses of possible modifications to training aeroplanes suspect of dangerous spin characteristics was undertaken for the RCAF."

Harvard Problems

Ground looping of the Harvard training aircraft became serious, resulting in damage to the aircraft if not to the occupants. This problem was investigated and as a result a small change in the tail wheel steering cable system was made which overcame the trouble.

The engine laboratory filled a long felt want. It contained two dynamometer test rooms with a capacity of 2,000 hp each; a hangar stand of 2,000 hp capacity; and a single-cylinder test room with three test beds. The first dynamometer operated in January, 1942, the second in April 1943 and the hangar stand was in operation in January 1942.

A 5,000 hp dynamometer, made up of two 2,500 hp eddy current dynamometers, was installed and in operation by March, 1945.

Some of the operations carried out in this laboratory are described by M. S. Kuhring and the following extracts are taken from his report.

British Parts Shortage

"The laboratory was of considerable assistance in aircraft engine supply and maintenance. A shortage of perhaps one particular component would hold up the assembly of many engines in overhaul shops. The supply of parts for British engines was at times interrupted or ceased. Sources of alternative parts were found and type approval runs made in the laboratory on the engine to determine that the alternative parts were satisfactory.

An example of the work carried out is that done in connection with the provision of replacement cylinder barrels for the Cheetah engines. Mr. Kuhring writes:

"British built 'Cheetah' engines had been used extremely in the British Commonwealth Air Training Plan and thousands of cylinders were worn out.

"As replacement cylinders could not be obtained from England, centrifugally cast steel cylinders were obtained from the Ford Motor Company and tested in the laboratory as a replacement for the original forged steel cylinders.

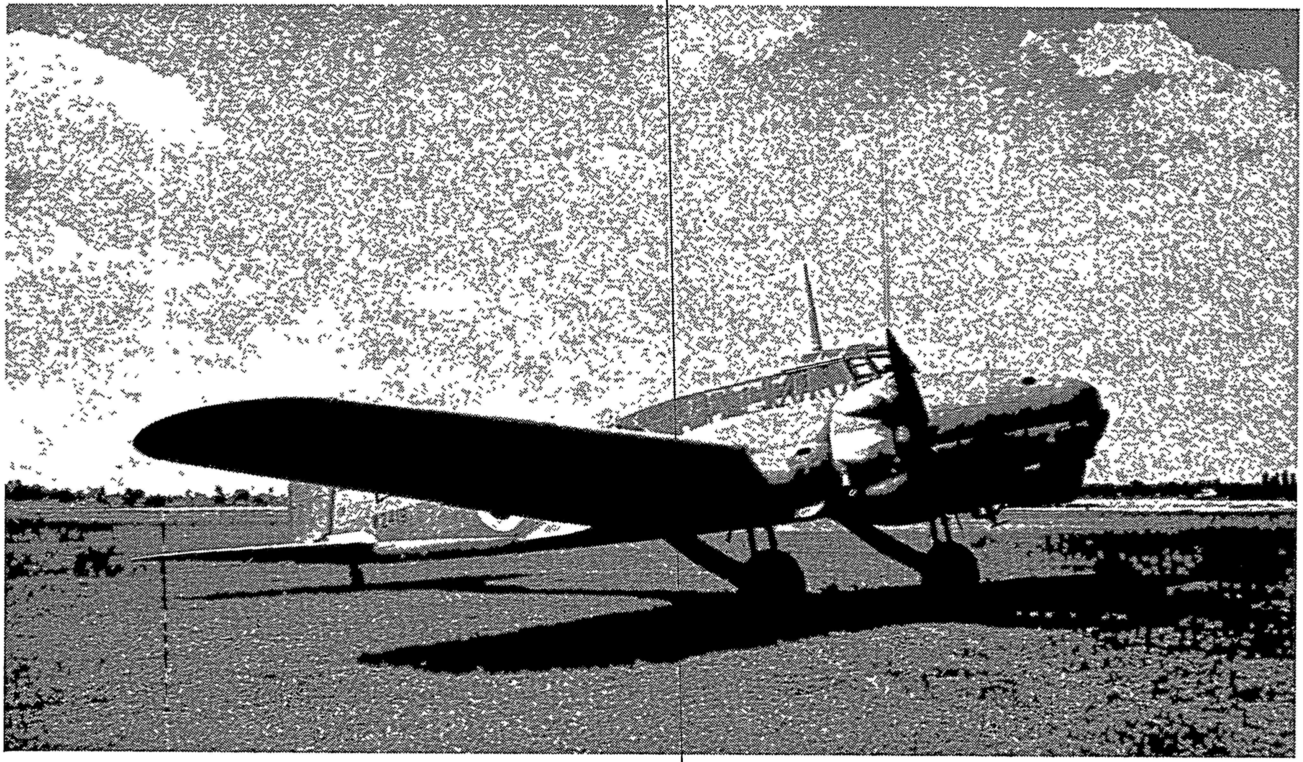
"Production of these new clyinders, found to be as good as or better than the original cylinders, released over two thousand engines for training."

The supply of propellers was important and the type test of a propeller make in Canada was undertaken. About this Mr. Kuhring writes:

"The Hoover constant speed propeller and governor were produced in Canada by the Canadian Car and Foundry Company, Montreal.

"No propeller-whirling stands being available in Canada, the propeller was whirl-tested in the United States. The engine laboratory was then requested by the Royal Canadian Air Force to undertake engine type approval of the propeller and governor for use in aircraft. Both components proved entirely satisfactory.

"Success of this investigation was important not only in introducing a new Canadian product, but also in ameliorating the supply situation which at that time was becoming acute."



TRAINER WORKHORSE of the RAF and RCAF, the Anson has remained in service with the former since before the war.

From Boxkite to Jet

Test Facilities Mushroom

By A/V/M E. W. Stedman

The Aeronautical Engineering School, located in Montreal, Que., was organized under the command of S/L T. R. Loudon, in March 1940 to train aircraft maintenance officers. The first class commenced in April 1940 with a quota of fifteen students. The idea was, at first, to draw upon young engineers from universities and technical colleges.

Subsequently, the personnel for training were recruited from among maintenance N.C.O.'s in the field, who were recommended for further training and promotion to commissioned work if their examination records were high enough.

Lectures on theory covering mechanics of materials, metallurgy, electricity and theory of flight were given; but the main training was in practical shop work, airframe and power plant overhaul and maintenance organization and procedure. The course was 22 weeks in length.

Instructional staff was drawn from university graduates and officers and non-commissioned officers of the RCAF and RAF.

In November 1940 S/L Loudon was posted to the Test and Development Establishment and the school was taken over by S/L A. S. Summers, RAF.

The purpose of the Test and Development Establishment was to provide an organization at Rockcliffe Airport, Ottawa, at which operations and investigation could be carried on in flight testing, redesign projects, electronics, gunnery, navigation and any suggestions which could be of interest in the aeronautical field as it affected the Allied training scheme.

First operations were commenced in November 1940, under W/C Fred Halliday, with W/C T. R. Loudon, as chief technical officer. S/L Evan Briggs, and subsequently S/L Gordon, were chief test pilots with a staff of F/L Holman, F/L Wiseman, W/O Beeston, F/L King and F/L A. McNaughton. The latter acted as gunnery officer with S/L McLaughlin in charge of electronics. F/L G. McManus was chief maintenance officer.

The accompanying table gives some idea of the diversity of tests carried out during the period November 1940 to March 23, 1943. During this period, and for a year or so afterward, there were about thirty different types of aircraft in the establishment hangars at any given time.

The table shows that 400 different orders were issued by AFHQ in a period of 873 days, a rate of slightly less than one every 2.2 days.

Deicing tests began in 1940 and continued throughout the war and for many years afterward largely carried on by J. L. Orr of the N.R.C. Many

Test and Development Establishment Program

	Tests	Armament	Radio	Skis	Parachute	Deicing	General	Total
1940 from Nov. 1 ...	1	3		1		1	4	10
1941	28	40	21	7	2	1	89	188
1942	19	28	7	10	6	3	92	165
1943 to Mar. 23	3	5	4	4	2	2	17	37
TOTALS:	51	76	32	22	10	7	202	400

FAMILIAR BIRD at left is Harvard trainer, while rare bird on right is the Fairey Battle, early wartime arrival in Canada.

tests on oil dilution were also carried out.

When aluminum was in short supply for a period during the war, a plywood Anson fuselage was built by Vidal and fitted with ordinary Anson wings and undercarriage at the T. and D.E. This gave a very smooth surface and great things were expected but the gain in speed was very small although the weight was slightly reduced.

A test of a Ventura aircraft on skis was carried out at Port Arthur on the ice by F/L Don Holman. It was in this test that the I/W method of reduction was used for the first time in Canada.

450-ft. Test Basin

A model test basin, larger than the one at John Street, Ottawa, was built in November, 1941. It was 25 feet wide, 10 feet deep and 450 feet long. There was some delay in getting the carriage fully operative but it was completed in Feburary, 1944. In the meantime the RCAF had been fully occupied with the Air Training Plan which called for the use of landplanes. Most of the work carried out in the model test basin was for the Navy.

The structures laboratory was completed in May, 1941. It included a tensile and compression testing machine of 60,000 lbs. capacity, and two cookers for plastic moulding. An addition to this laboratory was made in June, 1945.

In his report on some of the studies undertaken in this laboratory R. D. Hiscocks writes:

"During the latter part of 1941, a series of accidents of unexplained origin to a type of twin engine aeroplane used in the Commonwealth Air Training Plan resulted in a flutter investigation which included ground vibration tests. The results obtained in these laboratories revealed that structural failures due to tail flutter were quite probable. Recommendations were forwarded to the Department of National Defence for Air. An independent parallel investigation conducter in the United States sustained these results."

The department was always faced with the question as to the steps that should be taken to ensure the continuation of air training without interruption in the event of a serious shortage of aluminum for the manufacture of aircraft. The work carried out by the National Research Council in the connection is described by Mr. Hiscocks:

"At the beginning of the war, there was instituted in the division of mechanical engineering a program to develop and encourage the use of wood and plywood in aeroplane construction.

"In addition to the vast quantiy of raw material available there existed in the wood industries in Canada a very large skilled labor force not directly engaged in the war effort.

"Enquiries received from the Department of National Defence for Air and from the Department of Munitions and Supply indicated that assistance with wooden aircraft production problems could most effectively be extended to the industry by setting up a small pilot plant which in cooperation with the Forest Products Laboratories would develop and demonstrate plywood moulding and gluing techniques. It was recognized that a complete absence of wood design data applicable to modern aircraft structures existed and it was decided to undertake the design of a prototype wooden aircraft and in conjunction with this to conduct a testing program which would furnish design data.

"The Department of National Defence for Air and the Department of Munitions and Supply suggested the design and construction in design work initiated immediately.

"Early in 1941, it was decided that Anson wing production in Canada had progressed to the stage where any alterations in design were undesirable. Design work was accordingly initiated on a moulded plywood version of the rear fuselage and tail surfaces of the Harvard advanced trainer aeroplane.

"As an aluminum shortage sufficiently critical to warrant a changeover in Harvard production became less probable, the urgent need for a plywood alternative diminished and it became necessary to reduce the priority of this work in order to cope with the greatly increased volume of structural work. The first Harvard unit, comprising rear fuselage and tail surfaces, was strength tested during the latter part of 1942.

Wood Structure Testing

"The results fully established the ability of the plywood to compete with the contemporary metal on a strength to weight basis. A second unit was prepared for flight testing in September 1943 and, after preliminary flight trials at RCAF Test and Development Establishment, Rockcliffe, was assigned to routine flying at Uplands Air Station."

The structures laboratory was always available for strength tests of any part of an aeroplane that needed investigation. A typical example is also described by Mr. Hiscocks:

"At the request of the Department of National Defence for Air, a series of strength tests were performed on on the wings of Tiger Moth trainer aircraft in order to determine the extent to which the strength of such wings diminishes with the length of service. Sample wings were tested in various attitudes under different loading conditions and, in the absence of any evidence of a significant deterioration in strength with length of service, the decision was taken to extend the permissible life of such wings."

A gasoline and oil laboratory was completed in December, 1941, and additions made in February, 1945. Some of the work carried out in this laboratory is best told by quoting from the report made by Dr. J. W. Broughton.

"Work on hydraulic fluids was initiated at the request of the Deputy Minister of National Defence in November 1939, at which time there were no standardized Canadian fluids. Two general problems were outlined; (1) to prepare tentative specifications for aeroplane hydraulic fluids suitable for use in Canadian weather conditions and in the aeroplane mechanisms in use at that time; (2) research to establish the necessary characteristics of hydraulic fluids for aeroplane hydraulic mechanisms and shock absorbers.

"Aircraft hydraulic fluids perform the function of transmitting power for operating retractable undercarriages, wing flaps and power operated rotating gun turrets. The fluids must be capable of operation over the full range of temperatures from hot summer to the lowest temperatures experienced in high altitude flights (about —75 F). They must also have satisfactory lubricating properties, have only small swelling effect on rubber glands and meet certain other requirements."

The outcome of this work was the issue of a number of specifications for different types of hydraulic fluids for use in the aircraft systems.

Pump Failure Probed

The work has to be kept continually under review as the following extract from Dr. Broughton's Report will indicate:

"In October 1942, trouble was experienced due to failures of hydraulic pumps in Mosquito aircraft. At the request of the RCAF this problem was investigated. It was found due to the fact that 24-GR-1 fluid would not satisfactorily lubricate the type of pump used in this aircraft at the fluid pressures employed, which were much higher than in older aircraft. The whole problem of hydraulic fluids was reviewed on the suggestion of the RCAF and report NC-417 was issued in February 1943."

Some of the most important work carried out in this laboratory was in connection with aircraft fuels, not only in the preparation of specifications but also in the routine testing of fuels that were delivered to the service. Dr. Broughton writes:

"During the period of critical shortage of aircraft fuel the National Research Council in co-operation with the Associate Committee on Petroleum developed the use of thermally cracked aviation fuels for use in training aircraft. This development resulted in larger quantities of high octane blending agents and base stocks being made available for the manufacture of 100 octane fuel which was required for combat planes and trans-Atlantic flying. Full scale tests of thermally cracked fuel were done in the engine laboratory, and correlation with laboratory knock test engines was done in the gasoline and oil laboratory."

In the dealing with the tests of petroleum products against purchase specifications Dr. Broughton says:

"In addition the gasoline and oil laboratory undertook the testing of petroleum products to determine their compliance with the detailed requirements of purchase specifications. Substantially all the aircraft oils, greases and hydraulic fluids purchased by the RCAF were tested in the National Research Laboratories. Aviation fuels delivered east of the Great Lakes were tested by the National Research Council and those purchased west of the Great Lakes were tested by the gasoline testing laboratory, University of Alberta.

"Early in 1944 the RCAF adopted a new specification for 100 octane aviation fuel which included knock-rating requirements under rich mixture conditions. A supercharged co-operative fuel research knock test engine was installed in the gasoline and oil laboratory for this work. As this was the only such engine in Eastern Canada the laboratory undertook the testing of all 100 octane fuel to the new specification for the RCAF as well as the tests required by the oil companies for control of plant production."

A very difficult project, an icing wind tunnel, was commenced in October, 1942. Later it was decided to change the design and the tunnel was not completed at the end of the war.

The Air Research Committee was very interested in the whole question of aircraft de-icing and the National Research Council and the RCAF Test and Development Establishment conducted intensive flight research into this problem

The work was carried out largely by Messrs. Orr and Guthrie of NRC and E. Taylor from the Royal Aircraft Establishment in England. We must not, however, omit to mention the pilots and crew who were members of the staff at the Test and Development Establishment.

This work has been described in Wilfred Eggleston's "Scientists at War". When normal flying was stopped because of bad icing conditions, the experimental de-icing Hudson or Blenheim would start operation and the results so obtained contributed to the safety of flying under these difficult conditions.

Instrument Repair

The work of the aircraft instrument section of the mechanical engineering division has been covered in S. J. Murphy's report from which I quote as follows:

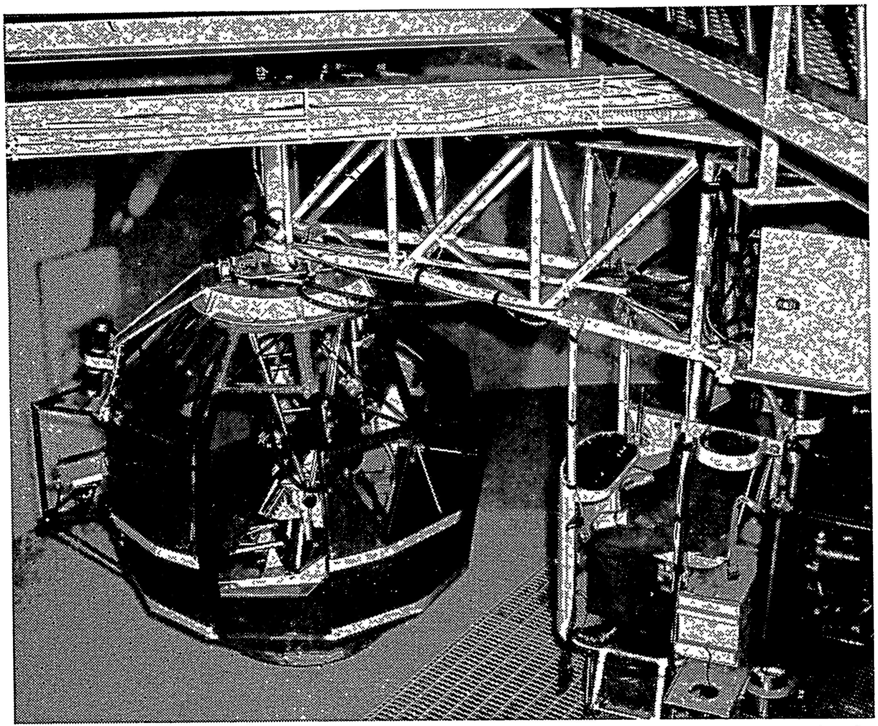
"The instrument section was for many years the sole instrument repair and calibration agency for the Royal Canadian Air Force. The period during which this arrangement was in force extended from the inception of the RCAF until a few years before the commencement of the present war. At that time the RCAF began a process of expansion which was greatly accelerated by the outbreak of the war.

"At the outbreak of war the instrument section was still carrying out a small volume of instrument repairs for the RCAF and for other government departments and it continued to do about the same volume of repair work throughout the war years. In the early months of the war the section gave considerable assistance, by advice and demonstration, to officers of the RCAF engaged in building up its instrument repair facilities.

"Also at the outbreak of war the section was still carrying out the acceptance tests of new instruments purchased by the RCAF and continued to do this work until the RCAF was able to develop its own test facilities.

"As a natural development of the experience gained in the repair, calibration and acceptance test of aircraft instruments and because of the possession of the needed equipment, all type approval tests of aircraft instruments required by the RCAF during the war were carried out by the section. These included instruments being considered for adoption by the RCAF or being manufactured in Canada for the first time. A number of type tests were also carried out at the direct request of the instrument manufacturers."

The instrument section also collaborated with the RCAF by giving assistance with the design of equipment for special purposes.



HUMAN CENTRIFUGE built at No. 1 Clinical Investigation Unit of the RCAF in Toronto, early in the war. Machine was used during development of the Anti-G suit.

From Boxkite to Jet

Probing Pilot Limitations

By A/V/M E. W. Stedman

I have been describing the research and development which went into improving the performance of aircraft under the pressure of wartime demands. In addition to making the machines better, we had to devise ways to increase efficiency and provide adequate safeguards for the men who operated them.

The Associate Committee for Aviation Medicine was involved in a number of fields of immediate interest to the service. I have mentioned my first contact with the effect of pilot blackout, during the Pullitzer Race at Detroit in 1922, when Lieut. Maughan side-slipped badly at the first pylon.

For many years the phenomenon was not often encountered, probably because planes were not constructed for high-speed or high-acceleration manoeuvres. The problem arose again when fighter aircraft of high performance, built to larger load factors, appeared. The physical capacity of the man then became the limiting factor.

Sir Frederick Banting constructed a human centrifuge, at No. 1 Clinical Investigation Unit RCAF in Toronto. It consisted of a man-carrying car which could be rotated in a circle of 32 feet diameter.

The centrifuge was used for experiments with the so-called "Anti-G" suit invented by Wing Commander W. R. Franks. This was a tight fitting suit, filled with liquid, which applied pressure to the lower parts of the pilot's body and counteracted the effects of high acceleration. Work along these lines was being done in both Canada and in England. Sir Frederick Banting was killed during a flight to England in connection with tests of this suit.

Night Vision Tests

Other medical experiments were being made in the field of night vision. Tests on cockpit lighting were carried out at the Test and Development Establishment under the direction of Tom Loudon (Professor T. R. Loudon of the University of Toronto) using red lighting in the cockpit. A demonstration was given me by Wing Commander K. Evelyn at McGill University. We were invited to sit in a room which apeared to us to be in complete darkness. We were told that we would gradually begin to see things on the wall ahead of us and were asked to say what we saw.

There were about four people of different ages present. First one and then another would say that the wall was no longer black but there were shadowy outlines visible. These shadows developed until after about 20 minutes we could see that there was a landscape scene projected on the wall from a faint light behind us. One feature in the landscape that I never did see was a slowly moving balloon.

We were told to put the ball of our thumb in one eye and a white light was flashed on for a very short time. The result was that we could now see nothing, as at the start, but we found that the eye that had been covered retained its night vision. A bright red light was switched on. This did not interfere with the night vision in the eye that had been covered.

During visits to training schools I referred to this work because I felt that even if red lighting was not available, members of the crew of an aircraft could protect their night vision if they knew what was involved.

Radar Pilot Aids

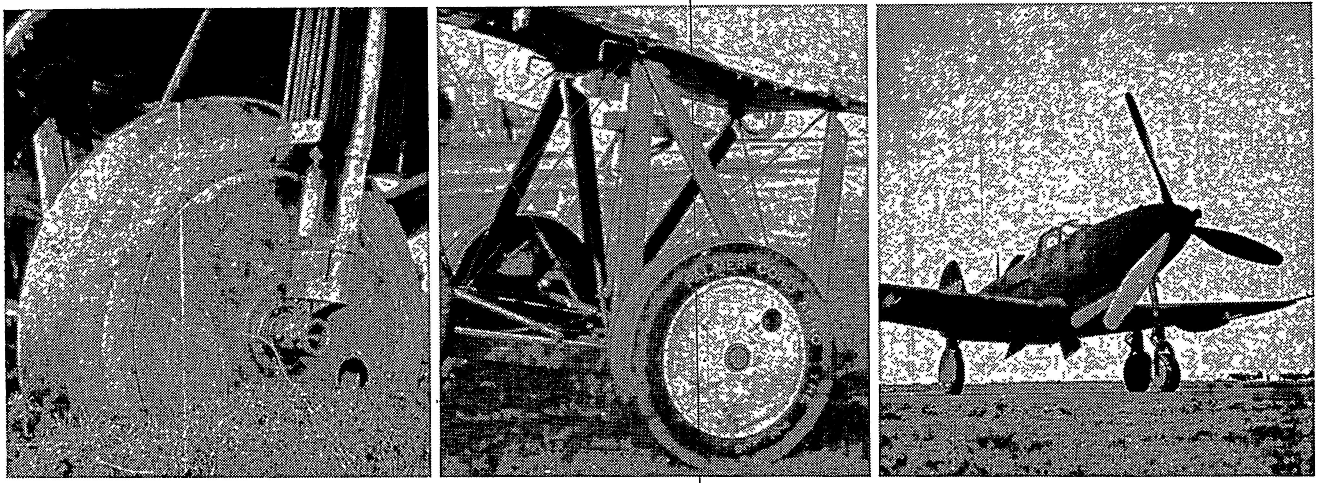
To ease the problem of landing an aircraft under conditions of bad visibility, several attempts had been made to provide a radio beam down which a pilot could fly to reach an aerodrome. The beam was followed on an instrument in the cockpit which showed the pilot where he was in relation to the beam. Beacons were added to provide an indication of positions along the beam. Several such systems were in use or being tested at the beginning of the war.

Dr. Luis Alvarez of the radiation laboratory at the Massachusetts Institute of Technology conceived that the anti-aircraft type of radar could be used to direct an aeroplane landing under adverse conditions. In November, 1941, tests of this theory were carried out at East Boston.

The device consisted of a portable radar station employing two beams, one in the vertical plane and the other in the horizontal plane. When an aeroplane was flying in a direction approximately approaching the station the image of the aeroplane on the radar screens could be kept central by moving the antennae; there was a screen for each dimension, i.e., vertical and horizontal.

Trial runs were made under conditions of good visibility during which the pilot made normal landings. The simultaneous positions of the images on the vertical and horizontal screens were recorded and from these records cams were made which would move the antennae in unison as determined by the cams.

If the same type of aeroplane landed on the runway, in exactly the same way as during the trial runs, the image of the aeroplane on the two radar



SQUARE-TREAD TIRES. Aircraft wheels bogging down in France in 1917 (left) led to the development of square-tread tires (centre). These were used again in World War II for the Bell Airacobra when operating the aircraft from grass strips in France.

screens would remain central during the landing. If there was any deviation from the path followed for the trial flights, that deviation would be visible on the screens. An operator at each radar screen kept the image central during the landing; a third operator was in radio contact with the pilot.

Under bad flying conditions the pilot would be directed, by other devices, to a position near the end of the runway. Then the operator in charge of the "Talk Down Blind Landing" would take over. The operators controlling the horizontal and vertical radar beams would adjust the antennae so that the image of the aeroplane was central. This position should correspond with the position predetermined and set on the cam for that particular type of aeroplane. Any divergence was indicated on dials in front of the main operator, who would then tell the pilot by radio that he was "too high" or "off to the left" etc.

The essential thing was that the conversation should be conducted with confidence and clarity. These directions allowed the pilot to correct his flight path, levelling out by visual means during the last few feet.

The device recalled an impression gained soon after the first war when our company, Handley Page Ltd., was operating some of the first passenger flights to Paris using converted bombers. Radio was just coming into use. One of the pilots, approaching the English Channel from the French side, found the channel covered with fog. He had a load of passengers and hesitated to enter the fog, because he did not know what the conditions were like on the other side. He spoke to a station on the English side and the reply was a cheerful voice which said "Come on, George; the sun is shining here."

Having seen the operation of the night bombers in England, I realized some of the difficulties when visibility at the home base became bad. I had a vivid mental picture of a young pilot returning from a raid with a damaged plane and perhaps some members of his crew wounded, finding his aerodrome blanked out and receiving a message to divert to some other aerodrome. How different his feelings would be if, as he approached his aerodrome, he heard the well-known voice of a trusted operator say "Come on, George; we have got you on the screen", and was then directed right down to the runway.

Pilots Not Impressed

I returned from Boston full of enthusiasm and was a little surprised when the senior officers with whom I discussed this device showed no enthusiasm. Being pilots, they felt that a pilot would never trust the operator on the ground.

There were many other people boosting this device and I added my weight to their efforts. During my extensive travels I spoke to a great many senior officers in Canada and Great Britain about its possibilities. After what seemed a long delay, an experimental set was sent to England in July, 1943, and used for landing bombers. Use of this equipment, particularly by the USAAF, developed rapidly during the latter years of the war.

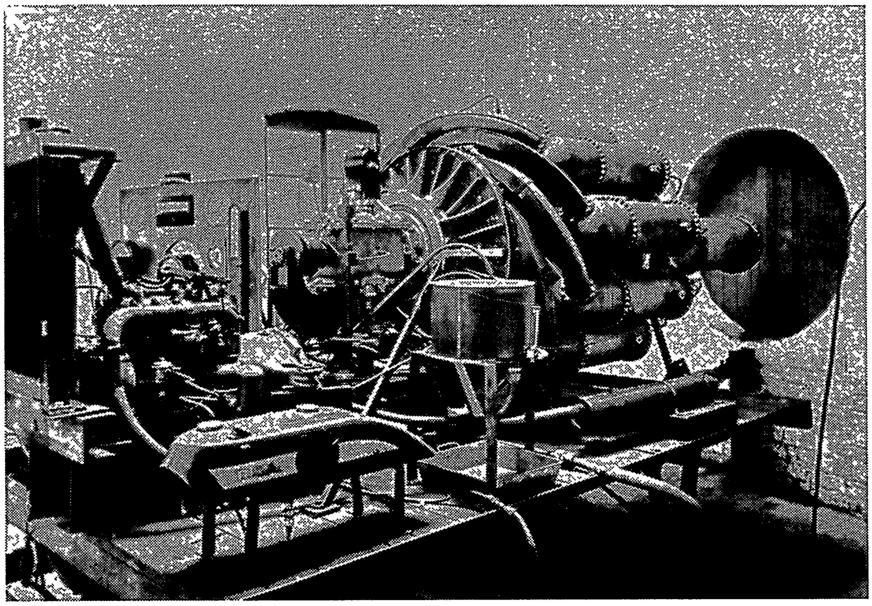
Soon after the war, civil aviation created a demand for additional facilities for landing under difficult conditions. This was met by the development of the "Talk Down Blind Landing", now called Ground Controlled Approach. The results obtained were very satisfactory and the pilots' prejudice partially overcome.

Often a little experience retained in one's memory may become of value at a much later date. On a visit to the Bell Aircraft Corp. at Buffalo, I believe it was in the fall of 1942, Larry Bell (the late Lawrence D. Bell, president of Bell Aircraft Corp.) told me of difficulty being encountered with the "Airacobra" when operating from grass aerodromes.

The wheels were so heavily loaded they sank into the ground. Larger wheels were out of the question because when retracted, they fitted into openings in the wings which could not be made larger without redesigning the wings and generally interfering with production. This reminded me of our experience in the 1914-18 war, operating heavy bombers in the Dunkirk area in Northern France. The aerodromes in the winter and spring were very soft. When the machines were fully loaded the wheels would sometimes sink into the mud as far as the axles.

The question was taken up with the Dunlop Rubber Company and they produced what we called the "square tread tyre" used on Short bombers. It was made by vulcanizing strips of rubber around the tyres at what might be called the shoulders thus producing a more or less square tread. The theory was that the rubber strips prevented the mud from squelching out sideways from the tread of the tyre.

Larry Bell thought this experience might assist in their trouble, and this proved to be the case. On my next visit in March, 1943, he told me that a tyre had been developed that met the requirements. Some work was involved in this development. It was found that a solid strip around the tyre overheated when operated at the speed of the more modern aeroplane and as a consequence it had been necessary to provide holes in the strips to allow cooling.



THIRD JET ON TEST. Considerably refined from the first model, but still very crude by present standards, Frank Whittle's third jet engine ran successfully in this test rig—aided apparently by the saddle tank from a BSA motorcycle (in foreground).

From Boxkite to Jet

Birth of the Jet Engine

By A/V/M E. W. Stedman

One of the problems in the expanding use of fixed wing aircraft in Canada was the provision of adequate ground facilities, with suitable landing areas in the remote areas in which we were often called upon to operate. In some cases we were able to overcome this by extensive use of amphibious aircraft. A vertical take-off machine, however, seemed the solution.

I have mentioned seeing the DeBothezat helicopter at McCook Field in 1923, when we were disappointed in its poor performance. After this I had no information on helicopter development until the war, when in April, 1942, on a visit to Wright Field, I saw a Sikorsky XR-4 helicopter fitted with a 175 hp Warner 'Scarab' engine.

Helicopters Turned Down

At that time I recommended that the RCAF should purchase helicopters for rescue purposes in the north country, a use for which they had not previously been considered. The type recommended, as the result of consultation with the officers at Wright Field, was the Sikorsky XR-6, which had a Pratt and Whitney 450 hp engine. A requisition for six helicopters was put forward, but it was refused by the Treasury Board because the price quoted contained a large charge for development costs.

In October 1943 John Parkin and I visited Wright Field again and saw the Sikorsky YR-4a helicopter with a 180 hp 'Scarab' engine. It had a 38-foot rotor instead of 36-foot blades previously used. Colonel Cooper took me for a demonstration flight in this helicopter, and shortly afterwards I had an opportunity to visit the Sikorsky factory where I saw details of construction and discussed the subject with Igor Sikorsky, whom I had known for some years due to our common interest in flying boats.

In the winter of 1942-43 Lloyd Breadner and I visited the Bell Aircraft Company at Buffalo where Larry Bell showed us a flying model of a helicopter in which he was interested. This was a small model about 15 inches in diameter, driven by an electric motor and operated by remote control. It served to illustrate the principles of the gyroscopic stabilizer bar which was the important new feature being introduced. This later developed into the now familiar Bell helicopter.

It was some years before any helicopters were acquired for use in Canada, due no doubt to the continued high development costs. The first helicopters were received by the RCAF in 1947.

Later development of the helicopter confirmed my early conviction that it would be invaluable for rescue and similar work in inaccessible areas in the north.

First Efforts at JATO

From 1942 until the end of the war John Parkin and I saw the work being done in California on jet-assisted take-off. We discussed this with Dr. F. J. Malina of the California Institute of Technology and subsequently saw demonstrations of this type of equipment.

At one time quite early in the war we considered the possibility of launching fighters in winter by attaching releasable skis provided with rockets to the wheels. The rockets would propel the skis and aeroplane until take-off speed was reached, then the aeroplane would lift off the chocks on the skis. The idea was never developed.

Problems on Propellers

By 1945 propellers were becoming very large and heavy. The Curtiss-Wright Propeller Co. developed a method of manufacture from steel sheet. The first process was to take a sheet of steel approximately the shape of one face of the blade and about half an inch thick. This was then placed in a press to put a bulge in it and the blade was milled, leaving a plate of tapered thickness.

To relieve the shortage of propellers during the Second War, local manufacture was undertaken. Mr. James Young, chairman of the board of Canadian Pratt & Whitney Aircraft Co. Ltd., wrote:

> "In World War II when the Canadian Government decided to manufacture propellers in Canada, we obtained for the government the license for the whole range of Hamilton Standard Propellers for nothing—all the Government paid was the actual cost of getting out the technical information. That was part of United Aircraft Corporation's and Canadian Pratt & Whitney Aircraft Co., Limited's con-

This is the last in a series of articles from the memoirs of the late Air Vice-Marshal Ernest W. Stedman, CB, OBE, M.I.C.E., F.R.Ae.S., F.I.A.S., Hon. F.C.A.I. Born in England, AVM Stedman came to live in Canada in 1920, served as Director of the Technical Branch of the Air Board and entered the RCAF on its organization. He retired from the RCAF in 1946, his last post being Air Member for Research and Development. For two years he was Air Adviser to the Chairman of the Defence Research Board, and for seven years Assistant Professor of Engineering at Carleton College, Ottawa. He died in 1957.

tribution to Canada's war effort. We started Canadian Propellers and finished it as a non-profit organization; we delivered over 13,500 propellers without profit."

The Hoover constant speed propeller was type-tested and approved for use in Canada and then manufactured by the Canadian Car and Foundry Co. in Montreal. This propeller later used wooden blades made by the Singer Mfg. Co.

Birth of the Turbine

My first recollection of the efforts made to apply the gas turbine to the propulsion of the aeroplane was when I was in college in 1910. We were told about the work being done by Holzwarth in Germany on the design of a 1,000 hp gas turbine. In fact, the engine developed only about 200 hp.

The use of the turbine as a prime mover developed slowly, but there was a commercial turbine, made by the Brown Boveri and Company, for use with the Houdry Oil-Refining process that came into use about 1936.

Frank Whittle (Air Commodore Sir Frank Whittle, KBE CB FRS) had been working on the idea of using a gas turbine to provide jet propulsion for an aeroplane for many years. In 1936 Power Jets Ltd. was formed by Whittle and some friends to develop the patents he held on jet propulsion. There were reports of Italian made jet propelled aeroplanes in Italy in August, 1940, and in November, 1941.

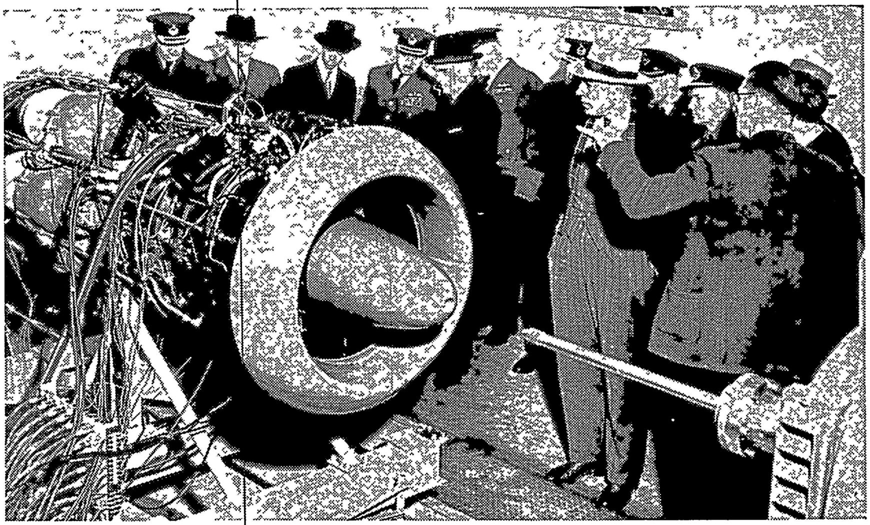
The first aeroplane designed for jet propulsion in England was the Gloster E 28/39. This machine was completed in April 1941 and flew in May, 1941, with very satisfactory results.

The Gloster jet demonstrated a much better performance than that of the 'Spitfire', and convinced me that here was something of the greatest interest to Canada. This aeroplane is now in the Science Museum in London, England.

The application of the turbine engine to aircraft propulsion was a long, wearisome struggle. The pre-war work of Frank Whittle and his associates attracted little attention until the struggle for air superiority provided the spur.

The first British fighter with jet propulsion was the Gloster F9/40 Meteor, powered by two Whittle engines. First proposed in April 1940, it was subsequently used for the destruction of V1 flying bombs.

The U. S. government was interested in the Whittle engine and decided to build a Whittle type engine at the General Electric Company works at Lynn, Mass. The USAAF arranged for the Bell Aircraft Corporation to design a fighter aircraft using two of the engines to be produced by G. E.



CANADIAN JET. First run of the Chinook engine at A. V. Roe Canada's Malton facility was an important milestone in Canadian aviation history. The engine is inspected here by RCAF officers and government and company officials.

A Whittle WIX engine had been flown to the United States at the end of Sept. 1941, to be used as a sample from which the G. E. design could be made. This historic engine was returned to England, but in 1949 it was presented to the Smithsonian Institute.

I reported to the Air Council, early in Oct., 1942, advocating that Canada enter the jet propulsion field. The Air Council passed this recommendation on to the Department of Munitions and Supply.

Acting on our recommendation, R. P. Bell, director general of aircraft production, suggested sending a team to England to investigate the question of the design and manufacture of jet engines in Canada.

Crown company formed

At a meeting held in Canada in May, 1944, the proposal was made that a Crown company be set up. This proposal was approved by the Minister of Munitions and Supply and in July, 1944, Turbo Research Ltd. was incorporated.

By March, 1945, the engineering staff of Turbo Research Ltd. had drawn up the preliminary details of two possible engines — one having a centrifugal compressor and the other having an axial flow compressor. The technical advisory committee met to consider these two proposals, presented by Ken Tupper.

The centrifugal compressor would undoubtedly have been easier to produce, but much work had been done on this type of engine in England by Power Jets Ltd., Rolls Royce Ltd., and de Havilland, putting us behind in experience. Another consideration was that the centrifugal compressor seemed to have limited possibilities for obtaining the required higher compression ratios for future development.

The axial flow type engine involved many unknowns. All engines produced to that time seemed to be capable of considerable improvement. It was felt that the number of stages for a given compression ratio could be reduced, i.e. it should be possible to obtain a greater compression ratio per stage. Also there were fewer limitations on the possible over-all compression ratio.

Axial flow decision

We, therefore, recommended that our first engine should have an axial flow compressor. This recommendation, which has since proved of the greatest importance, was accepted and the company was authorized to proceed with the design and construction of this engine.

At this time I retired from the RCAF and I was no longer associated with this work. Although I was reelected to the Board of Directors of Turbo Research Ltd., this company, shortly afterward, ceased to exist and the gas turbine work was transferred to A. V. Roe Canada Ltd. Later I was invited to witness the initial runs of the first "Chinook" engine.

Service requirements, as recognized by A/V/M James, now called for an engine of much greater thrust and the "Chinook" engine did not go into production; work began on the more powerful Orenda engine. The success of this project demonstrated Canada's ability to pace leading Western nations in aviation development.

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